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A THIRD JOURNEY OF EXPLORATION IN CENTRAL ASIA, 1913-16.

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BEFORE the close of March 1914 I had regained my old haunts of Tun-huang, and after a very brief halt to allow men and animals to recover from our trying winter campaign I started for the explorations planned eastwards. They were to take me mainly into the deserts which fringe on the south and east the great barren hill region usually designated as the Pei-shan Gobi. The distances were great and short the remaining season during which that waterless ground could be visited before the great summer heat set in. But even thus I could not forego a renewed visit to the famous cave temples of the "Thousand Buddhas" south-east of Tun-huang. There in 1907 I had been fortunate enough to secure such abundant antiquarian and artistic spoil from the walled-up temple cella, in which a whole library of Buddhist and other manuscripts and hundreds of fine paintings on silk had been hidden away early in the eleventh century together with a multitude of other relics.

I could not expect to make such a haul now. For when a year after my own visit, Professor Pelliot, on a mission from the French Government, had, with his expert knowledge of Chinese, searched the hoard and carried off a considerable selection of its remaining manuscripts, the attention of the authorities at Peking had been attracted to the old library, and its transfer to the capital was decreed. Of the careless and in reality destructive way in which the order had been carried out I found evidence in the many scattered rolls of Chinese Buddhist texts undoubtedly derived from this source which were offered to me for purchase at a number of towns both in Turkestan and Kansu. So it was satisfactory to find that somehow a considerable quantity of Chinese manuscripts from the walled-up cella still remained behind at the "Thousand Buddhas," and that my old priestly friend, Wang Tao-shih, was prepared to part with them in regard for a proper compensation for his pious establishment. He showed me with genuine pride the good use to which he had put the sum previously received from me, by building some gaudy new shrines and comfortable pilgrims' quarters. It was also reassuring to see that his personal relations

with the pious people of Tun-huang and their official guardians had evidently in no way suffered by our former little transaction. The only regret which it had left behind in the quaint little monk was that he had not been shrewd enough to accept the offer made by me in 1907 for the whole hoard, and had thus failed to save it from dispersion and to secure its full value for his shrine. Our reunion was throughout very cordial, and when we parted again my collection had received an appreciable addition of cases with old manuscripts and other relics in evidence of Wang Tao-shih's good will, and his appreciation of my ever-faithful attachment to the memory of holy Hsüan-tsang.

My immediate task, and one cherished ever since 1907, was to trace the line of the ancient Chinese *Limes* as far as possible to eastward, and to explore whatever ruins might have survived along it. After striking across a difficult belt of salt marshes, which nearly embogged my camels, I came again upon the ancient border wall halfway between Tun-huang and An-hsi. From there we succeeded in exploring its line for close on 250 miles eastwards. For almost the whole of this distance the wall, with its watch-towers and small military posts, had been built across what already in ancient times was absolute desert ground. The resulting immunity from human interference had contributed greatly to the preservation of the remains for fully two thousand years; but the remarkable method of construction employed was an even more important factor. The most destructive of natural forces in this region has always been slow-grinding but relentless wind-erosion. The wall or *agger*, built of carefully secured fascines of reeds, brushwood, or tamarisk branches, whichever of these materials were available in the immediate vicinity, was specially adapted to withstand it. Even where the watch-towers, once massively built in sun-dried bricks or stamped clay, had been under-cut by erosion at the base and been subsequently reduced to shapeless low mounds, difficult to recognize from a distance, the direction of the wall still clearly revealed itself, as it stretched away in a characteristic straight line across wastes of gravel or drift-sand.

The remains proved to have suffered most along that stretch of ground where the *Limes*, after crossing the Su-lo Ho to its right bank east of An-hsi, ran close to the deep-cut river-bed, and in a due easterly direction. On the bare riverine loess crossed here by the wall the erosive force of the prevailing north-east winds, blowing down with great violence from the gravel plateaus of the Pei-shan, could fully assert itself. But even where all structural features had been completely effaced it was easy for us with the experience gained elsewhere accurately to determine the position of the posts once guarding the border, from the fragments of pottery, coins, metal objects, and other hard débris which could be picked up at these points from the wind-worn surface. It was quite an exciting chase to search for these indications, and my Indian assistants and Turki followers had by now become expert in the game.

Where the Su-lo Ho valley bends sharply southward the line of the *Limes* was found to turn to the north-east, and to approach closer and closer to the foot of the Pei-shan. The ground crossed by it had remained so far unsurveyed, and the difficulties of our search were much increased by the distances which separated the long-forgotten border from the nearest water. Fortunately the days had now grown longer, and I was able to take out my little detachment of diggers mounted on the hardy big donkeys which abound at the oases of this region. Ample finds of ancient Chinese records on wood, articles of furniture, fragments of arms and implements rewarded the rapid search of the ruined watch-stations. That all these had been left behind by the Chinese troops, who during the first century before and after Christ had guarded this most dismal of frontiers, was made clear on the spot by conclusive archæological evidence. The finds of records still await expert examination by M. Chavannes, my learned Sinologue collaborator at Paris. They may be expected to furnish an important addition to the collection of early Chinese records resulting from my former explorations, which he had published in 1913.

Interesting light was thrown on the climatic conditions prevailing here from early times by the fact that here too the inscribed slips of wood, the "waste papers," to use an anachronism, thrown out of ancient office-rooms, were found often in refuse layers covered by a few inches only of gravel or débris. Their preservation in such conditions presupposes a remarkable dryness of the climate for the last two thousand years. Apart from this and the uniform barrenness, there was considerable variety in the natural features of the ground traversed by this eastern portion of the *Limes*. Thus all the more opportunity presented itself of observing the remarkable skill and topographical sense with which those old Chinese engineers of Han times had adapted their defensive border-line to different local conditions.

That they were prepared for great and sustained efforts demanding real powers of organization in the face of formidable natural obstacles was clearly demonstrated when, some 30 miles to the north-east of the little oasis of Ying-p'an ("the garrison") we found the *Limes* boldly carried into and through what since ancient times must have been a big area of drift-sand. Where not completely buried by high dunes, the wall built with tamarisk fascines, and of the usual thickness of 8 to 9 feet, still rose to close on 15 feet. Special difficulties must have been encountered in assuring water and supplies for the men guarding this section. In order to safeguard what evidently was an important line of communication and supplies leading to it, a chain of small fortified stations had been constructed to the south independently of the wall, but at the same period. It ran in the direction of the big oasis of Su-chou, an important Chinese base ever since Han times, and to this I turned when early in May it became necessary to make preparations for our next move northward.

I had planned to follow the united course of the rivers of Su-chou and

Kan-chou down into southernmost Mongolia, and to explore the ruins which the reports of Russian travellers had led me to expect along it and in its terminal delta. I was specially attracted to this ground by its geographical character, which suggested close resemblance to that of the Lop-nor region, and by the interest attaching to its earliest historical past. For we know that this region of the Etsin-gol, as the river is called by the Mongols, had been included in the wide dominion held by those earliest nomadic masters of Kansu, the "Great Yüeh-chih," the later Indo-Scythians, and the Huns, whose successive migrations westwards were destined to affect so deeply the history of Central Asia as well as of India and the West.

The effective intercession of H.M.'s Minister at Peking had secured for me a very friendly reception by the Chinese administration of the Kansu Province. The Tao-tai of Su-chou agreed to provide me with a recommendation to the chief of the Torgut Mongols who now graze in the Etsin-gol delta, and on May 10 I was able to set out northward. The track I followed down the river of Su-chou allowed me to approach once more the area where we had previously lost the line of the ancient frontier amidst high dunes. Pushing a reconnaissance into the stony desert north-west of the Chint'a oasis, I came upon remains of the *Limes* where it emerged on less impracticable ground near the south-eastern extremity of the Pei-shan. Thence we tracked it right through to the north of the Mao-mei oasis, the last Chinese settlement. There Lal Singh rejoined me after having followed a hitherto unsurveyed route along the river of Kan-chou, where it breaks in a picturesque gorge through the westernmost hill range of the Ala-shan.

In the valley of the Etsin-gol nature, by affording water and grazing, has ever provided an easy route for raids and invasions from the Mongolian steppes into the line of the westernmost Kansu oases, which itself constitutes the great natural highway connecting China with the Tarim Basin and innermost Central Asia. Ruined forts of imposing size and evident antiquity were found to guard the point where this route of invasion cuts through the ancient border-line drawn by the Chinese when they first occupied those oases in the reign of the great Han Emperor Wu-ti. One fort built with clay walls of exceptional strength looked an exact counterpart of the ancient frontier post of the "Jade Gate," famous in Chinese historical records, and previously identified by me on the Tun-huang *Limes*. We found evidence that the fortified border-line after crossing the Etsin-gol, north of Mao-mei, had continued through the desert eastwards. But when we came back in June from the Etsin-gol delta the summer heat had become too great to permit of further search on this waterless ground.

We found even in May our long marches trying as we moved down by the sandy bed of the Etsin-gol, nearly a mile wide in places, but absolutely dry at that time. Only at rare intervals could water be obtained from wells dug in deep hollows below the banks. Some 90 miles below

Mao-mei the river passes through a low rocky spur thrown out from the easternmost Pei-shan, and spreads out in a delta, which extends for over 110 miles to the north, terminating in a line of brackish lakes and marshes. The conditions brought about here by a succession of low-water seasons furnished a striking illustration of the appearance which the ancient Lou-lan delta we had explored in the winter may have presented before its final desiccation. Where river-beds lined by narrow belts of riverine jungle had been left dry for long years, we found many of the wild poplars already dead or dying. The wide stretches of ground separating the several beds showed but scanty scrub, or else were absolutely bare. No wonder that we heard sad complaints in the scattered camps of the two hundred odd Mongol families which are established in the Etsin-gol delta, about the increasing difficulties caused by inadequate grazing. Their chief, whom I visited on May 25 in his modest encampment, proved a well-meaning but weak individual, and his subjects as indolent as they were "much given to deceit," to use an expression of my Chinese patron saint. It was no easy matter to secure an adequate number of labourers for my intended excavations, and still more difficult to keep them at work, in spite of very generous pay.

Advantages of geographical position must at all times have invested this extensive riverine tract, limited as are its resources, with considerable importance for those, whether armed host or traders, who would make the long journey from the heart of Mongolia in the north to the Kansu oases. It had been the same with the ancient Lou-lan delta, without which the Chinese could not have opened up the earliest and most direct route for the expansion of their trade and political influence into Central Asia. The analogy thus presented could not fail to impress me even further when I proceeded to examine the ruins of Khara-khoto, the "Black Town" (Fig. 17), which Colonel Kozloff, the distinguished Russian explorer, had been the first European to visit during his expedition of 1908–09. There remained no doubt for me then that it was identical with Marco Polo's "City of Etzina." Of this we are told in the great Venetian traveller's narrative that it lay a twelve days' ride from the city of Kan-chou, "towards the north on the verge of the desert; it belongs to the Province of Tangut." All travellers bound for Kara-koram, the old capital of the Mongols, had here to lay in victuals for forty days in order to cross the great "desert which extends forty days' journey to the north, and on which you meet with no habitation nor baiting place."

The position thus indicated was found to correspond exactly to that of Khara-khoto, and the identification was completely borne out by the antiquarian evidence brought to light. It soon showed me that though the town may have suffered considerably, as local tradition asserts, when Chingiz Khan with his Mongol army first invaded and conquered Kansu from this side about 1226 A.D., yet it continued to be inhabited down to Marco Polo's time, and partially at least for more than a century later.

This was probably the case even longer with the agricultural settlement for which it had served as a local centre, and of which we traced extensive remains in the desert to the east and north-east. But the town itself must have seen its most flourishing times under Tangut or Hsi-hsia rule from the beginning of the eleventh century down to the Mongol conquest.

It was from this period, when Tibetan influence from the south seems to have made itself strongly felt throughout Kansu, that most of the Buddhist shrines and memorial Stupas dated, which filled a great portion of the ruined town and were conspicuous also outside it. In one of the latter Colonel Kozloff had made his notable find of Buddhist texts and paintings. But a systematic search of this and other ruins soon showed that the archæological riches of the site were by no means exhausted. By a careful clearing of the débris which covered the bases of Stupas and the interior of temple cellas I brought to light abundant remains of Buddhist manuscripts and block prints, both in Tibetan and the as yet very imperfectly known old Tangut language, as well as plenty of interesting relievos in stucco or terra-cotta and frescoes. The very extensive refuse heaps of the town yielded up a large number of miscellaneous records on paper in the Chinese, Tangut, and Uigur scripts, together with many remains of fine glazed pottery, and of household utensils. Finds of Hsi-hsia coins, ornaments in stone and metal, etc., were also abundant, particularly on wind-eroded ground.

There was much to support the belief that the final abandonment of the settlement was brought about by difficulties of irrigation. The dry river-bed which passes Khara-khoto lies some 7 miles to the east of the nearest branch still reached by the summer floods. The old canals we traced, leading to the abandoned farms eastwards, are removed considerably further. It was not possible to determine by conclusive evidence whether this failure of irrigation had been the result of desiccation in the Etsin-gol delta or been caused by some change in the river-course at canal-head, with which the settlement was for some reason unable to cope. But there seemed to me good reason to believe that the water-supply now reaching the delta during a few summer months would no longer suffice to assure adequate irrigation for the once cultivated area. Even at the Mao-mei oasis, over 150 miles higher up the river, and with conditions of ground far more favourable for the maintenance of a system of canals, serious trouble had been experienced for years past in securing a sufficient discharge early enough in the season, and much of the once cultivated area seemed to have been recently abandoned.

With the rapidly increasing heat, work at the desert sites had become very trying both for the men and our camels, upon which we depended for the transport of water. With the completion of our task at Khara-khoto, and of the surveys which had meanwhile taken Lal Singh to the terminal lake-basins of the Etsin-gol, I was glad to let the hard-worked camels depart for their much-needed summer holiday in the Kongurche

hills north-eastward and to start myself with Lal Singh south to the foot of the Nan-shan. The new route, which we were able to follow for part of the journey, took us through hitherto unexplored portions of the desert hills to the east and north of the river of Kan-chou. But owing to the heat and the scarcity of springs it implied serious fatigues, and it was a relief when Kan-chou was safely reached before the close of June.

A short but refreshing halt in that large and pleasant oasis was devoted to the arrangements needed for the new surveys I had planned in the Central Nan-shan. Their object was to extend the mapping which in 1907 we had effected in the high mountains near the sources of the Su-lo Ho and Su-chou River by accurate surveys of the high ranges further east, containing the headwaters of the river of Kan-chou. In conjunction with our labours in the Etsin-gol region, they were intended to complete the mapping of that large north-western portion of Kan-su which, inasmuch as it sends all its waters into drainageless basins, may well be claimed in respect of its hydrography and general physical conditions as belonging to Central Asia rather than to China. Knowing the reluctance of the local Chinese to venture far into those mountains, I was prepared for the difficulties experienced at the outset in securing transport. But a fortunate chance brought just then an old Chinese friend to the military command of Kan-chou in the person of worthy General Tsai, whose kindness I remembered so well from my visits to Su-chou in 1907, and his opportune help enabled us to set out for the mountains by the first week of July.

The route followed during the first marches acquainted me with a series of old Buddhist cave temples at Ma-ti-ssŭ, containing sculptures of Sung times, and with other interesting Buddhist remains in the pretty little town of Nan-kou-ch'êng at the foot of the mountains. The visit did not pass without profit for my collection of antiques, and also helped to make me realize that we were now near a dividing line of distinct geographical interest. For while to the west cultivation, whether in the plain or along the foot of the mountains, requires irrigation, we now came upon loess slopes and big alluvial fans which rainfall alone suffices to make fertile. Our approach to the watershed of the Pacific Ocean was appropriately foreshadowed by this marked change in climatic conditions.

Following the route which leads towards Hsi-ning and ascending through the picturesque gorge and the pass of O-po, we reached the broad valley where the easternmost feeders of the river of Kan-chou gather at an elevation of over 11,000 feet. Thence we were making our way westwards over high alpine grazing grounds frequented in the summer by Tangut herdsmen and horse-breeders, when I met with a serious riding accident which might well have put an end for ever to all my travelling. My Badakhshi stallion reared suddenly, and over-balancing himself fell backwards upon me, with the result that the muscles of my left thigh were severely injured. For over two weeks I was unable to leave my camp bed or to use the crutches we improvised. But fortunately the arrangements

already made allowed me to let Lal Singh proceed for the topographical tasks I had planned. He carried them through with all his wonted devotion and energy, and no time was lost in our programme. Nearly three weeks had passed when, with my leg still feeling the strain severely, I managed to get myself carried down in a litter to Kan-chou.

During a ten days' halt there I experienced much kindness from Father Van Eecke and other Belgian missionaries, and received the first confused news of the great European conflagration. Then I set out by the third week of August for the long-planned journey through the Pei-shan Gobi. It was to take me back to Turkestan for the work of the autumn and winter. Eight long marches brought me to Mao-mei by a new route skirting the hills on the right bank of the river of Kan-chou, and allowed me to view the remains of the late mediæval "Great Wall" which runs on to, and ends near, Su-chou. The complete decay into which it has fallen for considerable distances, notwithstanding its relatively recent origin, helped me to appreciate all the more the time-resisting solidity which the methods of construction employed by the engineers of Han times had assured to their *Limes* wall. I reached Mao-mei exhausted by the effort which it had cost me to do this journey on horseback, because of the severe strain to my leg. But I found there my brave camels safely arrived and was cheered by Lal Singh rejoining me. By exceptional efforts my indefatigable old travel companion had succeeded in extending our Nan-shan surveys eastwards over an area quite as large as that mapped in 1907.

On 2 September 1914 we commenced the journey which was to carry us right across the great desert area occupied by the ranges of the Pei-shan, where its width is greatest, in the direction from south-east to north-west. The routes we followed for close on 500 miles had never been surveyed, and I knew that only at one point, the cross-roads of Ming-shui, could we expect to touch ground the position of which was known relative to the routes previously visited by Russian travellers. Wherever possible we moved in two parties and by different routes, in order to increase the extent of the area mapped. For this purpose I had secured at Mao-mei the only two guides available, both Chinese. But their local knowledge, even when combined, proved very inadequate, and after less than half of the journey it gave out altogether. We were thus obliged to trust largely to the guidance of the faint caravan tracks traceable and to what information we opportunely obtained at the single small Mongol camp encountered. The scarcity of wells and of grazing implied serious risks in this mode of progress and made it an anxious time for me, especially as I had found the strain of riding too painful and was obliged to direct our moves from an improvised pony litter.

It was reassuring when, after passing the well of Ming-shui, the great snowy mass of the Karlik-tagh came into view, far away to the north-west, and served to direct us in the rough. But great difficulties still awaited us in the last barren hill range through which we had to make our way, owing

to want of water and the very confused and, in places, rugged configuration of its valleys. It proved an easternmost extension of the T'ien-shan system. When we had safely emerged from it through narrow tortuous gorges which ever threatened to stop our camels far away from water or grazing, it was a real relief to look down on the open Dzungarian slopes and sight some 15 miles away a tiny spot of dark trees. It was the little village of Bai, for which I had wished to make all the time, and after nearly four weeks of continuous travel it was no small satisfaction to have safely reached it without the loss of a single animal. There was reward for our troubles in the extensive plane-table surveys, supported here as all through our journeys by astronomically observed latitudes and by many careful height observations with mercurial barometer and clinometer. They will throw fresh light, I hope, on the morphology of the Pei-shan ranges.

A rapid journey subsequently carried me during October along the north foot of the eastern portion of the T'ien-shan range, already bearing its first winter snow, to Barkul and Guchen (Ku-ch'êng-tzŭ). The ground crossed here, topographically better known, had a special interest for me as it helped to acquaint me with the peculiar physical conditions of a region through which many of the great historical migrations westwards, like those of the Yüeh-chih or Indo-Scythians, Huns, and Turks, must have passed. These valleys and plateaus of Dzungaria, favoured by a climate less dry and possessed of abundant grazing-grounds, have often played an important part in the history of Eastern Turkestan. They have again and again afforded a temporary home to nomadic tribes. These could never have maintained their flocks and herds in the arid planes of the Tarim Basin; but they were always able from across the T'ien-shan to carry out their raids into it and exact tribute from its flourishing oases. I could observe a curious if faint reflex of those great tribal movements in the numerous camps of Muhammadan Kazaks, fine men of Turkish speech and descent, whom the Mongols had driven south under Chinese protection since they secured the "independence" of Outer Mongolia.

After leaving Guchen I surveyed, near Jimasa, the remains, extensive but badly decayed, marking the site of an ancient capital of this region, which under the names of Chin-man and Pei-ting often figures in the Chinese Annals from Han to T'ang times. Its connection with the Turfan oases to the south had been a very close one from an early historical period, and as Turfan was to be my base for the winter's labours I was very glad to march there by the most direct route, hitherto unsurveyed. It led me across the Bogdo-ula range, a rugged portion of the T'ien-shan rising to numerous snowy peaks, by a pass close on 12,000 feet (Fig. 18), and once again confirmed the accuracy of the early Chinese itineraries in which this route is described.

The first week of November 1914 found the four parties into which my expedition had divided since September safely reunited at Kara-khoja, an important ancient oasis in the centre of the Turfan depression. A

combination of geographical and archæological reasons had made me fix upon Turfan as the base and chief ground for our labours of the ensuing winter. It was certainly the natural and most convenient starting-place for the series of tours I was anxious to organize for the exploration of unknown or as yet inadequately surveyed portions of the Kuruk-tagh and Lop deserts to the south. I myself, ever since my brief visit of 1907, had felt drawn back to Turfan by the hope that its abundant ruins of Buddhist times were not yet completely exhausted, even though, easily accessible as they are, within or quite close to oases, they had received much attention from successive archæological expeditions, Russian, German, and Japanese. Finally, geographical and antiquarian interests united in prompting me to make an accurate large-scale survey of the Turfan Basin; for, apart from its containing in its terminal salt lake what probably is one of the deepest depressions below sea-level of our globe, there is the important fact that, within close topographical limits, and hence in a concentrated form, as it were, it exhibits all those characteristic physical features which make its great neighbour and counterpart, the Tarim Basin, so instructive both to the geographer and historical student.

This detailed survey of the Turfan depression, on the large scale of 1 mile to an inch and with clinometrically observed contours, was taken in hand by Surveyor Muhammad Yakub almost as soon as he had joined me after a difficult desert crossing from the terminal drainage basin of Hami or Kumul. A few days later I could send off R. B. Lal Singh, pining as always for fresh hard work, to the Kuruk-tagh. The rapidly increasing cold, felt even here close to sea-level, gave hope by then that he would be able to overcome the difficulties arising in those truly "Dry Mountains" from the want of drinkable water, by the use of ice formed on salt springs —or of snow if such happened to fall.

With my remaining two Indian assistants I had already started the archæological labours that were to keep us busy for the next three and a half months. The ruined town, known as Idikut-shahri, which was their first scene and adjoins Kara-khoja, has long ago been identified as the site of Kao-chang (or Khocho in early Turki), the Turfan capital during T'ang rule (seventh to eighth century A.D.) and the subsequent Uigur period. Massive walls of stamped clay enclose here an area, nearly a mile square, containing the ruins of very numerous structures, built of sun-dried bricks or clay. Most of them were Buddhist shrines and several of imposing dimensions. For generations past these débris-filled ruins have been quarried by the cultivators of the adjoining villages in search of manuring earth for their fields, and many of the smaller structures had been levelled to gain more ground for cultivation. Since the excavations made here between 1902–06 by Professors Grünwedel and Von Lecoq, of the Berlin Ethnographic Museum, the villagers had extended their destructive operations in the hope of securing manuscript remains and antiques as valuable by-products for sale to Europeans. Of such finds I was able to acquire

FIG. 17.—RUINED BUDDHIST RELIC TOWERS ON NORTH-WEST CORNER OF TOWN WALL, KHARA-KHOTO.

FIG. 18.—VALLEY BELOW PANOPA PASS, BOGDO-ULA RANGE, LOOKING SOUTH.

FIG. 19.—RUINED BUDDHIST SHRINES AND CAVE-TEMPLES BELOW MURTUK, TURFAN.
Drift-sand covers hill slopes in background.

FIG. 20.—HEAD OF BOSTAN-ARCHE VALLEY, ULUGH-ART RANGE, LOOKING WEST.
Surveyor Afrazgul in foreground. Clouds above head of valley hide snowy peak over 22,000 feet.

a fair number. But it was more satisfactory to find that in some ruins deeper débris strata had escaped exploitation. Their systematic clearing was rewarded by a variety of small but interesting remains, such as fresco pieces, fragments of paintings on paper and cloth, stucco relievos, illustrating Buddhist art at Turfan. Manuscript fragments in the Uigur, Tibetan, Chinese, and Manichæan scripts were also recovered. The discovery of a hoard of well-preserved metal objects, including decorated bronze mirrors, ornaments, etc., offered special interest, as the large number of coins found with it permits the date of its deposit in Sung times to be fixed with approximate accuracy. Simultaneously with these clearings I had an exact plan of the whole site prepared.

After rapid visits to smaller sites in the eastern portion of the Turfan Basin I turned, towards the close of November, to the ruins in the picturesque gorge of Toyuk. There numerous rock-cut caves, once occupied by Buddhist priests, honeycomb precipitous cliffs rising above the small stream that waters a flourishing little oasis, famous for its grapes. Where the slopes are less steep, narrow terraces have been built, bearing small Buddhist shrines, now in ruins. At the most conspicuous of these the second German expedition had made important manuscript finds. Stimulated by these in their monkey-like emulation, native searchers for antiques had subsequently wrought terrible havoc among ruins which had before remained more or less untouched. Lower down, however, we succeeded in tracing remains of shrines which had been protected by heavy covering masses of débris, and the employment of large numbers of diggers to clear them was easy. After the difficulties to which my previous work at desert sites far away from habitations and water had accustomed me, conditions of work in the Turfan district seemed, in fact, quite "suburban," as it were. In the end we recovered at Toyuk a considerable quantity of fine frescoes and stucco relievo pieces. Fragments of Chinese and Uigur texts were numerous.

From Toyuk I proceeded by the middle of December to an important Buddhist site below the village of Murtuk. It occupies a conglomerate terrace on the steep west bank of the stream watering the Kara-khoja oasis, where it breaks in a narrow wild gorge through the barren hill range overlooking the main Turfan depression (Fig. 19). The extensive series of ruined shrines, partly cut into the rock, had been decorated with frescoes representing scenes of Buddhist legend and worship in a great variety of subject and style. In richness and artistic merit they surpassed any similar remains in the Turfan region, and recalled the pictorial wealth of the "Thousand Buddhas" caves near Tun-huang. In 1906, Professor Grünwedel, with his intimate knowledge of Buddhist iconography and art, had carefully studied these big wall paintings, and a considerable selection of fresco panels was then removed to Berlin. For long centuries the frescoes had been liable to suffer casual injury at the hands of iconoclast Muhammadan visitors. During recent years they had been exposed to even

greater damage from natives, who, in vandal fashion, cut out small pieces for sale to Europeans. The risk of further destruction in the near future was only too obvious, and careful systematic removal presented the only means of saving as much as possible of these fine remains of Buddhist art. Fortunately, I could utilize for this long and difficult task the trained skill and manual experience of Naik Shams Din. Working with devoted energy, and valiantly helped by Afrazgul, he successfully accomplished it in the course of six weeks. Carefully drawn plans had been prepared for their guidance. Meanwhile I was able to pay a rapid visit to Urumchi, the provincial headquarters, where I had the great satisfaction of seeing again my old Mandarin friend, learned P'an Ta-jên, then holding high office as Financial Commissioner of the 'New Dominion.' As on my former journeys he did his best to help me in my scientific aims.

Early in January 1915 work had progressed sufficiently to allow me to apply myself to the clearing of smaller Buddhist ruins near Murtuk, and then to a task which proved as fruitful as it was to me novel and in some ways unpleasant. Below the debouchure of the gorge which brings down the streams of Murtuk and Sengim, and above the large village of Astana adjoining Kara-khoja from the west, there extends over the gravel-covered waste a vast ancient burial-ground. It is marked by small mounds covered with stones and by low lines of embanked gravel which enclose these mounds to form scattered groups. The mounds indicate the position of tomb chambers which are cut into the underlying hard layer of fine conglomerate or sandstone. A narrow rock-cut passage, originally filled in again, led deep down to the entrance of each tomb, which itself was closed with a wall. Most of these tombs appear to have been searched for valuables during the last Muhammadan rebellion, and probably also earlier. But drift-sand had completely closed up the passages of approach, and only during the last few years had the tombs attracted attention from local antique-hunters. Their operations had not proceeded far, and gave anyhow useful assurance as to the absence of any local prejudices.

Willing labour could be secured in plenty, and made easy the opening of very numerous tombs in rapid succession. The systematic search of each has conclusively demonstrated that the cemetery dates from the early T'ang period, and mainly the seventh century A.D. Then Kao-chang, the present Turfan, was an important administrative centre and garrison of the Chinese after their reconquest of Eastern Turkestan. Exact dates, names of persons, and other details are furnished by the Chinese inscriptions on bricks which were found intact near the approaches of many tombs. Their decipherment by my distinguished Sinologue collaborator, M. Chavannes, is likely to clear up the question as to whether the tombs were occupied exclusively by Chinese or contained also dead from among the indigenous population. Without a detailed examination and comparison of all these finds and observations, which may not be possible for some time, it would be premature to interpret the interesting burial customs revealed

by these tombs; nor can I find space here to discuss them and their variations.

The dryness of the Turfan climate accounts for the remarkable state of preservation in which most of the bodies and the objects deposited with them were found. The latter comprised a great variety of articles of food, dress, personal use and the like, which the dead were supposed to need. Among them I may mention pastry of many shapes, showing familiar Indian ornamental motifs; boxes with ladies' toilet outfits; arms, etc. Whether of actual size, or reproduced in miniature, these objects, together with the painted stucco figurines representing attendants, richly caparisoned horses, household animals, etc., acquaint us with many aspects of the daily life led in Turfan at that period. I cannot pause to give details. It must suffice to record that the archæological spoil has been as varied as it was abundant. But I may at least briefly refer to finds strikingly illustrating the position which Turfan and probably other oases of Chinese Turkestan occupied at that period, as places of trade exchange between Western Asia and China. Thus we found Byzantine gold pieces regularly placed, much in the fashion of the classical obolus, in the mouth of the dead, and Sassanian silver coins over their eyes. The custom of wrapping up the bodies in torn pieces of manifold garments has provided us with a rich collection of fine silk materials. Among these there is a curious abundance of brocades and other decorated fabrics showing designs which are usually associated with Persian work of Sassanian times. Paintings on silk, too, were found, meant to decorate the dwellings of the dead, and a quantity of manuscript records, mainly Chinese.

Interesting and fruitful as this search was, I felt a strong longing for a chance of resuming exploratory tasks in the open air of the desert. But my leg had not yet recovered from the accident in the summer, and could not face long tramps such as a return to the wastes of the Lop desert would have necessitated. So I had to be content with what satisfaction Lal Singh's safe return towards the close of January from his expedition into the 'Dry Mountains' brought me. In the face of great physical difficulties and risks he had accomplished important survey work. After reaching Singer, the only permanent homestead in that vast area of barren plateaus and hills, he had started triangulation, and in accordance with my instructions carried it south-east to the vicinity of the Lou-lan ruins in the wind-eroded desert. His patient wait there for a week, amidst icy gales and with temperatures falling well below zero Fahrenheit, was rewarded when the dust-laden atmosphere cleared at last and allowed him to connect his triangles with previously "fixed" high peaks of the snowy K'un-lun range some 150 miles south. Thus it became possible later on to realize my hope of getting the Indian triangulation system extended by this link to the T'ien-shan range in the north.

With Abdur Rahim, the experienced hunter of wild camels from Singer, whose help had proved so valuable to us a year before, Lal Singh

had then pushed into the unexplored and absolutely sterile region to the north-east of Altmish-bulak. His fuel supply had given out for several days, and he had to brave the severe cold of the nights without a fire before he decided to turn again westwards from beyond 91° long. He then picked up an old desert track once used by hunters of wild camels from Hami, before certain salt springs had dried up, and followed it down to the salt marsh that forms the deepest part of the Turfan Basin. There he took numerous observations with the mercurial barometer which, I hope, will make it possible to determine its depression below sea-level with greater accuracy. In spite of all he had gone through, Lal Singh allowed himself but a brief rest at our base, and by the first week of February set out afresh for the Kuruk-tagh.

The packing of our plentiful "archæological proceeds" from Turfan had cost great efforts. But at last, on February 6, I could start my big convoy of antiques, making up fifty camel-loads, under Ibrahim Beg's care for its two months' journey to Kashgar. On the same day I sent off Afrazgul Khan to the Lop desert for a supplementary survey of the Lou-lan region and the dried-up ancient sea-bed to the east and south. I myself proceeded to Yar-khoto for a detailed survey of this curious site, where a maze of ruin dwellings and shrines carved out of the loess soil of an isolated and naturally strong plateau represents the remains of the earlier Turfan capital during Han times. Some days more were taken up by arrangements for the completion of the large-scale map of the Turfan depression in six sheets and by the collection of supplementary data bearing on its extant irrigation resources. Their comparison with those which must be assumed to have existed in Buddhist times is made particularly instructive by the fact that now the greater portion of the cultivated area is irrigated from *karezes* or springs tapped by underground canals, a system which is known to have been introduced into Turfan from Iran only during the eighteenth century. My last days at Turfan were made somewhat anxious by a renewed attempt at Chinese obstruction, now directed against my archæological activity. Fortunately this time, too, I was on the point of starting into desert parts where no interference with my plans was practicable, and the safe transit of my antique collection, about which I had reason to feel apprehensive, was secured by the prompt steps my old friend, Sir George Macartney, took to parry the stroke from Provincial headquarters.

On February 16 I left Turfan for the Kuruk-tagh, and having secured from Singer Abdur Rahim's youngest brother as guide, examined several localities in the mountains westwards, such as P'o-ch'êng-tzŭ and Shindi, where traces of earlier occupation were reported. The succession of remarkably rugged ranges and deeply eroded valleys through which we had to thread our way contrasted strikingly with the appearance of worn-down uplands presented by most of the Kuruk-tagh eastwards. I was able to map here a considerable extent of ground which had remained

unsurveyed. Apart from another brother of Abdur Rahim, who was grazing his flocks of sheep in the gorge of Shindi, and a solitary Turki who was taking supplies to a spot where a few Chinamen were said to dig for lead, we met no one. The absence of springs or wells precludes the regular use of what scanty grazing is to be found in the higher valleys. Yet in the Han Annals this westernmost portion of the Kuruk-tagh is referred to as a sporadically inhabited region under a separate chief.

Over absolutely barren gravel wastes I then made my way south-eastwards to the salt spring of Yardang-bulak, or *recte* Dolan-achchik, at the extreme foot of the Kuruk-tagh, where wild camels were encountered in plenty. Taking my ice-supply from there, I proceeded by the second week of March into the waterless desert south, and mapped there the dried-up ancient river-bed, which once had carried the water of the Konche-darya to the Lou-lan sites, over the last portion of its course left unsurveyed last year. The season of sand-storms had now set in, and their icy blasts made our work here very trying. It was under these conditions, fitly recalling the previous year's experience at the Lou-lan cemeteries, that I explored two ancient burial-grounds of small size, which were found on clay terraces rising above the wind-eroded plain. The finds closely agreed with those which the graves, searched on the fortified Mesha in the extreme north-east of Lou-lan, had yielded. There could be no doubt that the people buried here had belonged to the autochthonous population of hunters and herdsmen living along the 'Dry River' until the tract became finally desiccated in the fourth century A.D. The objects in these graves and the clothes of the dead strikingly illustrated how wide apart in civilization and modes of daily life these semi-nomadic Lou-lan people were from the Chinese frequenting the ancient high-road which passed by the dried-up river.

I had been eagerly looking out along the foot of the Kuruk-tagh for traces of Afrazgul, who was overdue, and had taken the precaution to leave messages for him under cairns. So it was a great relief when, the day after my return to Yardang-bulak, he safely rejoined me with his three plucky Turki companions, including doughty Hassan Akhun, my camel factotum, and Abdul Malik, a fourth hardy brother from Singer. Considering the truly forbidding nature of the ground they had to traverse, and the length of the strain put on our brave camels, I had reason to feel anxious about the safety of the party. Now I was cheered by the completeness with which Afrazgul had carried through the programme I had laid down for him. Having gained Altmish-bulak by the most direct route and taken his supply of ice there, he had explored certain ancient remains in the extreme north-east of the once-watered Lou-lan area, for the examination of which I had been unable to spare time on last year's march.

He then struck out for the point where the ancient Chinese route had entered the salt-encrusted bed of the dried-up sea, and thence traced its shore-line to the south-west, until he reached, at Chainut-köl, the northern

edge of the area, where the spring floods of the Tarim finally spread themselves out, to undergo rapid evaporation in lagoons and marshes. He arrived, as I had intended, just in time before the usual inundation could interfere with his progress. After a few days' rest, with water and grazing for the camels, he turned into the wind-eroded desert north, and traced more remains of the ancient settlement discovered a year before along the southernmost branch of the 'Dry River.' Finally, after crossing an area of formidable high dunes, he gained the foot of the outermost Kuruk-tagh. From this exceptionally difficult exploration, which had kept the party from contact with any human being for a month and a half, Afrazgul brought back, besides interesting archæological finds, an accurate plane-table survey and detailed diary records. It is impossible here to discuss the results. But when considered with those which the previous year's surveys had yielded they will, I feel confident, help to show the so-called Lop-nor problem in a new light.

We subsequently moved west to the point known as Ying-p'an, where the ancient bed of the Kuruk-darya is crossed by the Turfan-Lop track. I made use of a short halt there for exploring the interesting remains of a ruined fort and small temple site, found some miles beyond at the debouchure of the dried-up stream of Shindi, and first noticed by Colonel Kozloff and Dr. Hedin. The finds we made here of fragmentary Kharoshthi records on wood and of Han coins were important as proving that the ruins belonged to a fortified station occupied during the early centuries of our era when the ancient Chinese high-road coming from Lou-lan passed here. The station was meant to guard an important point of the route where it must have been joined by the road leading up from Charchan and Charkhlik. That it held a Chinese garrison became evident from the remains we found on clearing some well-preserved tombs in a scattered cemetery near by. There was definite evidence showing that the site abandoned for many centuries had been reoccupied for a while during Muhammadan and relatively recent times. Now the water needed for irrigation is wholly wanting.

Proceeding from Ying-p'an I first surveyed in the desert westwards the ancient bed, still marked by its rows of fallen dead trees, in which the waters of the Konche-darya had once passed into the 'Dry River' of Lou-lan. My subsequent journey to Korla, by a route leading through the desert north-westwards, and first followed by Dr. Hedin in 1896, enabled me to explore the remains of an ancient line of watch-stations extending for over 100 miles along the foot of the Kuruk-tagh. These watch-towers, some of them remarkably massive and well-preserved, showed the same characteristic features of construction with which my explorations along the ancient Chinese *Limes* of Kansu had made me so familiar. There can be little doubt, I think, that these towers date back to approximately the time (*circ.* 100 B.C.) when the Emperor Wu-ti had the route leading from Tun-huang towards Lou-lan protected by his wall and line of watch-

stations. From the great height and intervening distances of the towers, as well as from other indications, it may be safely inferred that they were primarily intended for the communication of fire signals, such as are frequently mentioned in the early Chinese records I recovered from the Tun-huang *Limes*.

The need for such signalling arrangements must have been specially felt here, as it was mainly from the direction of Kara-shahr and Korla that the Hun raids must have proceeded, which we know from the Annals to have more than once threatened the Chinese hold upon Lou-lan and the security of their route to the Tarim Basin. With the gradual extension of Chinese political influence north of the T'ien-shan these conditions changed, and subsequently the abandonment of the Lou-lan route, and the desiccation of the region it led through, must have greatly reduced the importance of this ancient line of communication along the Konche-darya. Yet the line marked by the towers appears to have continued in use as a high-road down to T'ang times, as was shown by the finds of coins, torn documents on paper, etc., we made on clearing the refuse heaps near them.

My visit to the quasi-peripatetic modern colony of Kara-kum on the upper Konche-darya gave me opportunities for curious observations about irrigation conditions and Chinese administrative methods; but I cannot pause to describe them. At the large and flourishing oasis of Korla higher up the river I had soon the satisfaction of seeing, by the beginning of April, our four surveying parties safely reunited. Lal Singh had succeeded in carrying his triangulation from Singer through the western Kuruk-tagh to the snow-covered peaks north of Korla. His dogged perseverance had triumphed over exceptional difficulties, both from the very broken nature of the ground and the adverse atmospheric conditions, which a succession of the violent duststorms usual at this season had created. The reward was the successful linking I had aimed at, of the T'ien-shan range with the system of the Trigonometrical Survey of India.

From Korla we set out on April 6 in three separate parties for the long journey to Kashgar. Lal Singh's task was to keep close to the T'ien-shan and to survey as much of the main range as the early season and the available time would permit. Muhammad Yakub moved south across the Konche and Inchike Rivers to the Tarim, with instructions to survey its present main channel to the vicinity of Yarkand. I sent most of our brave camels with him in order to let them benefit by the abundant grazing in the riverine jungles after all the privations they had gone through. My own antiquarian tasks obliged me to keep in the main to the long line of oases which fringes the south foot of the T'ien-shan and through which the chief caravan route of the Tarim Basin still passes, just as it has always done since ancient times. Well known as this high-road is over which lay most of my journey to Kashgar, some 900 miles in length, the opportunities it gave for interesting observations, both on the historical geography and the present physical and economic conditions of this

northern fringe of oases, were abundant. But here a brief reference to the result of my work round Kucha must suffice.

Three busy weeks spent within and around this historically important oasis enabled me with Afrazgul's help to survey both its actually cultivated area and that which, by the evidence of the numerous ancient sites found scattered in the scrubby desert to the east, south, and west, must have formed part of it. This survey, which archæological finds of interest at a number of ruined sites usefully supplemented, has given me strong grounds for assuming that the area occupied in Buddhist times demanded for its cultivation irrigation resources greatly in excess of those at present available, of which I secured careful estimates. It seems to me clearly established that the discharge of the two rivers feeding the canals of Kucha has diminished considerably since T'ang times. But the antiquarian evidence at present obtainable does not allow us definitely to answer the questions as to what extent this obvious "desiccation" was the direct cause for the abandonment of once irrigated areas, and at what particular periods it proceeded. Here I may also mention in passing that remains of the ancient Han route, in the shape of massive watch-towers, could be traced as far as Kucha, and that their position clearly indicated that the old caravan route had followed the same line as the present one.

After visiting a number of interesting Buddhist ruins in the district of Bai, I travelled to Aksu, where Lal Singh's and my own routes opportunely allowed a brief meeting. He had managed to carry his plane-table survey at three points up to the snow-covered watershed of the T'ien-shan, including the glacier pass below the high massif of Khan-tangri. Help I secured from the obliging Tao-tai of Aksu subsequently enabled him to follow a new route on his way to Kashgar, between hitherto unexplored outer ranges of Kelpin.

Regard for urgent tasks obliged me to move in rapid marches to Kashgar, which was reached on 31 May 1915. There at my familiar base I was received with the kindest hospitality by Colonel (now Brigadier-General) Sir Percy Sykes, who had temporarily replaced Sir George Macartney as H.B.M.'s Consul-General. Though a shooting-trip to the Pamirs soon deprived me of the congenial company of this distinguished soldier-statesman and traveller, I continued to benefit greatly by all the help and comfort which the arrangements made by him assured to me during my five weeks' stay at Chini-bagh.

The safe repacking of my collection of antiques, filling 182 heavy cases, for its long journey across the Kara-koram to Kashmir, and a host of other practical tasks kept me hard at work all through that hot month of June. In the midst of it I felt greatly cheered by receiving the final permission of the Imperial Russian Government for my long-planned journey across the Pamirs and the mountain north of the Oxus, which the kind offices of H.E. Sir George Buchanan, H.B.M.'s Ambassador at Petrograd, at the instance of the Government of India in the Foreign

Department, had secured. Considering how long I had wished to see this extreme east of ancient Iran, and that part of the "Roof of the World" under which it shelters, I could not feel too grateful to the Imperial Russian Government for having shown this readiness to give me access to ground which for the most part had never before been visited by any British traveller. Its diplomatic representative at Kashgar, Consul-General Prince Mestchersky, lost no chance of facilitating the arrangements for my journey by kind recommendations to the Russian authorities across the border. But throughout it was a great comfort to feel, during that time of preparation, and still more on actual travel, how much of that kind help and attention I directly owed to Lord Hardinge, and the alliance of the British and Russian Empires he had done so much to render possible.

By 6 July 1915 I was able to leave Kashgar for the mountains westwards, after having completed all arrangements for the safe passage of my eighty heavy camel-loads of antiques to India. But the summer floods in the K'un-lun valleys, due to the melting glaciers, would not allow the valuable convoy to be started at once towards the Kara-koram passes. So R. B. Lal Singh, to whose care I had to entrust it, had set out in the meanwhile to complete our topographical labours in Turkestan by a careful survey of the high snowy mountains, which continue the Muztagh-ata range to the headwaters of the Kashgar River. Before he rejoined me for manifold final instructions I could enjoy a week of delightful seclusion for much urgent writing work, on a small fir-clad alp above the Kirghiz camp of Bostan-arche (Fig. 20). Lower down in the valley my brave hardy camels had enjoyed weeks of happy grazing in coolness, badly needed after all their long travels and trials. When the time came for my start, I confess I felt the final separation from them almost as much as the temporary one from my devoted Lal Singh. Of my other assistants I kept by me only young Afrazgul, whom I knew to be ever useful, even where survey work or digging could not be done. The rest were to accompany my collection to India.

It was with a delightful sense of freedom that on July 19 I started from my mountain camp for the high Ulugh-art Pass and the Pamirs beyond. For across them the road lay now open for me to those mountain regions north of the Oxus, which by reason of their varied geographical interest and their ethnic and historical associations have had a special fascination for me ever since my youth. On the following day I crossed the steep Ulugh-art Pass, about 16,200 feet above sea-level, flanked by a magnificent glacier some 10 miles long. There I felt duly impressed with the fact that I had passed the great meridional mountain barrier, the ancient Imaos, which divided Ptolemy's "Inner" and "Outer Scythia," as in truth it does now Iran and Cathay. The same night, after a 33 miles' walk and ride, I reached the camp of Sir Percy Sykes returning from the Pamirs, and next day enjoyed a time of happy reunion with him and his sister, that well-known traveller and writer, Miss Ella Sykes.

Five days of rapid travel then carried me over the northernmost Chinese Pamirs and up the gorge of the westernmost headwaters of the Kashgar River, until I struck the Russian military road to the Pamirs on the Kizil-art Pass where it crosses the Trans-Alai range. At the little rest-house of Por-döbe, which I reached that evening on my descent from the pass, I soon received most encouraging proof of the generous and truly kind way in which the Russian political authorities were prepared to facilitate my travels. There I had the good fortune to meet Colonel Ivan D. Yagello, who holds military and political charge of the Pamir Division, including now also Wakhan, Shughnan, and Roshan; he was then just passing on a rapid visit to Tashkend. I could not have hoped even on our side of the Hindukush border for arrangements more complete or effective than those which proved to have been made on my behalf by this distinguished officer. It was for me a great additional pleasure to find in him an Oriental scholar deeply interested in the geography and ethnography of the Oxus regions, and anxious to aid whatever investigations could throw fresh light on their past. It was mainly through Colonel Yagello's unfailing aid that I succeeded in covering so much interesting ground, far more than my original programme had included, within the available time and without a single day's loss. I shall always look back with sincere gratitude to his friendly interest and all the generous help which he and his assistants, officers at the several Russian Pamir posts, gave me.

One of the chief objects which I had in view, when planning this extension of my journey across the Pamirs and the Russian territories on the Oxus, was to study there questions of historical geography, in the way which experience elsewhere in the East had taught me to be the best, *i.e.* on the spot. Hence it was a special satisfaction to me that at the very start I was able to march down the whole length of the big Alai Valley, a distance of over 70 miles. In the topographical configuration, climatic conditions, and local resources of this great Alpine basin I could trace additional indications supporting the belief that through this wide natural thoroughfare, skirting the northern rampart of the Pamirs from east to west, passed the route which the ancient silk traders from China followed down to the Middle Oxus, as outlined by that much-discussed record of classical geography where Marinus of Tyre describes the progress in the opposite direction of the agents of "Maës the Macedonian" from Bactria to the great silk mart in "the country of the Seres" or China. Similar observations make it appear to me very probable that the famous "Stone Tower" mentioned in that record must be located at or near Daraut-kurghan, a small Kirghiz village and now a Russian frontier customs post, where the route up the main Kara-tegin Valley emerges upon the Alai; it is the only direct one between Bactria and Eastern Turkestan which is practicable throughout for laden camels.

From Daraut-kurghan, where our supplies could conveniently be

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FIG. 21.—GLACIER PEAKS OF 'MUZ-TAGH' ABOVE MUK-SU, SEEN FROM WATERSHED (CIRC. 11,000 FEET) ON TARS-AGAR PASS.

FIG. 22.—HEADMEN OF UPPERMOST ROSHAN VALLEY AT SAUNAB.

FIG. 23.—GORGE OF BARTANG RIVER, ABOVE BARCHIDIW, BLOCKED BY LANDSLIDE.

Newly formed tarn in foreground; former river-bed buried under rock-débris.

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replenished, I turned south to strike across the succession of high snowy ranges which separate the headwaters of the Muk-su and the rivers of Roshan and Shughnan from the uppermost Oxus. It was the only route, apart from the well-known one leading across the Kizil-art and past Lake Kara-kul, by which I could cross the Russian Pamirs and their western buttresses from north to south, and this accounted for my choosing it. But it proved a distinctly difficult route to follow, even with such exceptionally hardy animals as Colonel Yagello's orders secured for me from the rare Kirghiz camps encountered. There was, however, abundant reward in the mass of interesting geographical observations to be gathered and in the splendid views which it offered into a region of permanent snow and ice little explored and in parts still unsurveyed.

As far as the Tanimaz River, a large tributary of the Bartang or Murghab River, our route led past a grand glacier-clad range, vaguely designated as Sel-tagh or Muz-tagh, and still awaiting exact survey, which forms, as it were, the north-western buttress of the Pamirs. Rarely have my eyes in the Himalaya, Hindukush, or Kun-lun beheld a sight more impressive than the huge glacier-furrowed wall of the "Muz-tagh" (Fig. 21) as it rose before me with magnificent abruptness above the wide torrent beds of the Muk-su, after I had crossed the Tars-agar, our first pass from the Alai. Its boldly serrated crest-line seemed to rise well above 20,000 feet, and individual ice-peaks may reach a considerably greater height. No approximately exact elevations seem so far to have been determined with the theodolite or clinometer for this and some other prominent ranges towering above the western portion of the Pamirs, and neither Afrazgul nor myself could help feeling again and again regret at the obvious considerations which precluded our attempting survey work however modest in scope. Subsequently it was a real satisfaction to come across evidence of the systematic triangulation work which the Topographical Service of Russian Turkestan has been extending over the Pamirs for some years past, and to learn that it was steadily being continued in spite of the war.

Our direct route past the Sel-tagh would have led up the valley by which the Zulum-art and Takhta-koram passes, giving access to the Kara-kul and Tanimaz drainage areas, are approached. But the floods fed by the huge Sel-darra Glacier completely close this route from spring time till the late autumn, just as they render the track lower down the Muk-su quite impracticable for the greater part of the year.* So we were obliged to make our way first over the glacier pass, *circ.* 15,100 feet high, at the head of the Kayindi gorge. The latter proved to be completely blocked in places by ancient moraines and offered very difficult going. Here, as

* This Muk-su gorge is in places even during winter too difficult for laden animals. To find it actually marked in a recent cartographical representation as traversed by the ancient silk trade route seemed an illustration of the risks which beset the work of the historical geographer when it has to be done solely in the study.

elsewhere, in the high mountains west of the Pamirs, evidence could be noted of glaciation having considerably receded during recent times.

Beyond the Kayindi the ground assumed a much easier Pamir-like character, and after crossing the Takhta-koram Pass, *circ.* 14,600 feet, we reached on August 8 the first encampment of Kirghiz grazing in the open valleys to the south-west of the Great Kara-kul. Having obtained there fresh transport from imposing old Kokan Beg, the Ming-bashi of the northern Pamirs, and having started my anthropometric work, I moved down the Tanimaz Valley to its junction with that of the Murghab or Bartang River. Here at the picturesque hamlet of Saunab, the Tash-kurghan of the Kirghiz, I reached the first Iranian-speaking settlement of hill Tajiks or Ghalchas, all fine-looking men (Fig. 22). Their ethnic type of pure *Homo alpinus*, their old-world customs, preserved by alpine isolation, and the survival of much that seems ancient in domestic architecture, decorative motifs, etc., interested me greatly and amply justified a day's halt, which allowed me to secure anthropological measurements and arrange for the load-carrying men we needed.

The only route open to us for reaching the southern Pamirs led up by the Bartang River, and progress in its narrow gorges proved exceptionally trying owing to the results of the great earthquake of 18 February 1911, which had transformed the surface of this mountain region in a striking fashion. Already on the lower Tanimaz we had come upon huge masses of rock débris which had been thrown down from the slopes of the flanking spurs and now spread for miles across the open valley bottom. Here in the defiles of the Bartang the huge landslides attending that memorable earthquake had choked up in many places the whole river passage and practically destroyed what tracks there ever existed along or above it. The big river once rivalling in volume the main feeder of the Oxus, the Ab-i-Panja, had here ceased altogether to flow. Strings of deep alpine tarns, with colours of exquisite beauty, had replaced it here and there and helped to increase the difficulties of progress (Fig. 23). It took three days' hard scrambling along steep spurs almost impassable for load-carrying men, and over vast slopes of rock débris spread out in wildest confusion, to get beyond the point near the mouth of the Shedau side valley (Fig. 24), where the fall of a whole mountain has completely blocked the river, and converted the so-called "Sarez Pamir" into a fine alpine lake over 15 miles long now and still spreading up the valley.*

Enormous masses of rock and detritus had been shaken down from the range on the north and had been pushed by the impetus of the landslip

* In an important paper (*Comptes rendus de l'Académie des Sciences*, clx. pp. 810 *sqq.*, Paris, 1915), reference to which I owe to Mr. E. Heawood's kindness, Prince B. Galitzine has shown strong reasons for the belief that the Sarez landslide was not the consequence but the cause of the earthquake of 18 February 1911, which was registered at many distant seismological stations. This earthquake is declared to present an exceptionally interesting case where the epicentre can be proved to coincide with the hypocentre itself.

FIG. 24.—BARRAGE THROWN ACROSS BARTANG VALLEY BY LANDSLIDE, WITH WESTERN END OF NEWLY-FORMED SAREZ LAKE.

View from circ. 12,000 feet height on Marjanai spur, looking to north-west. Clouds of dust raised by rock movement on higher slopes mark where mountain had fallen in earthquake of 1911.

FIG. 25.—OXUS VALLEY AT JUNCTION OF AB-I-PANJA AND GREAT PAMIR RIVER, SEEN FROM RATTJN ABOVE LANGAR-KISHT.

FIG. 26.—OXUS VALLEY WITH HINDUKUSH PEAKS ABOVE DARRA-I-PANJA, SEEN FROM RUINED FORT ABOVE ZANG (VIEW TO SOUTH-EAST).

up the steep spur flanking the Shedau debouchure. They had thus formed a huge barrage which even now seemed to rise more than 1200 feet above the level of the new Sarez Lake, and is likely to dam it up for years, if not for centuries. It cost another day's stiff, and in places risky, scramble before we succeeded in getting the baggage safely across the few miles of precipitous rock slopes and dangerous débris-shoots above the Yerkht inlet. Fortunately the men collected from the uppermost hamlets of the Roshan Valley proved all excellent cragsmen and quite expert in building *rafaks* or galleries of brushwood and stones along otherwise impassable precipices.

Opportunely succoured by Kirghiz ponies, which had been sent from the Alichur Pamir to meet us, we crossed the Langar Pass, close on 15,000 feet above the sea, by August 20. It gave us easy access to the Yeshil-köl Lake, where I found myself on ground of varied geographical interest. I can mention only two points here and those in all briefness. On the one hand, with the experience gained at the newly formed big lake fresh before me, it was easy to recognize those topographical features which clearly point to the Yeshil-köl having derived its existence from a similar cataclysm at some earlier period. To the eyes of the non-geologist the formation of the Buruman ridge, which closes the western end of the lake, seemed to bear a close resemblance to the newly formed barrage which has created the Sarez Lake. Of glacier action, which might have produced the same result, I could see no trace on either side of the Yeshil-köl exit. On the other hand, what I observed on my way up the open Alichur Pamir, and subsequently in the main Shughnan Valley below it, bore clear evidence to the advantages which the route leading through them had offered for Chinese expansion to the Upper Oxus and Badakhshan ever since Kao Hsien-chih's memorable Pamir and Hindukush campaign of 747 A.D.

Having crossed the Bash-gumbaz, our fourth pass over 15,000 feet since leaving the Alai, I descended to the glittering big expanse of Lake Victoria or Zor-köl, where the Great Pamir branch of the Oxus rises, and the Pamir borders of Russia and Afghanistan meet. Ever since my youth I had longed to see this, the truly "Great" Pamir and its fine lake, famous in early local legends, and the "Great Dragon Lake" of the old Chinese pilgrims. As I looked across its deep blue waters to where in the east they seemed to fade away on the horizon, I thought it quite worthy to figure in early tradition as the legendary central lake from which the four greatest rivers of Asia were supposed to take their rise. It was a delightful sensation to find myself on ground closely associated with the memories of those great travellers, Hsüan-tsang, the saintly Chinese pilgrim-geographer, Marco Polo, and Captain Wood, the first modern explorer of the Pamir region.

The day of halt, August 27, spent by the sunny lake-shore, undisturbed by any sign of human activity, was most enjoyable, in spite of the bitterly cold wind sweeping across the big alpine basin, *circ.* 13,400 feet above sea-

level. It allowed me to gather local information, which once more confirmed in a striking fashion the accuracy of the Chinese historical records. In describing Kao Hsien-chih's expedition across the Hindukush, the T'ang Annals specially mention the concentration of the Chinese forces by three routes from east, west, and north, upon Sarhad, the point on the Ab-i-Panja branch of the Oxus, which gives direct access to the Baroghil and Darkot Passes. The routes from the east and west, *i.e.* down and up the Ab-i-Panja Valley, were clear beyond all doubt. But of the northern route no indication could be traced in maps or books, and the existence of a pass, vaguely mentioned in native intelligence reports as possibly leading to Sarhad, across the high snowy range south of the Great Pamir, had been denied by members of the British Boundary Commission of 1895 who visited this region.

It was hence a pleasant surprise when inquiries from two much-travelled Kirghiz among our party elicited definite and independent evidence as to an old track still used by Tajik herdsmen, which leads from Sarhad across the range to the glacier-filled head of the Shor-jilga Valley, clearly visible from Lake Victoria, and thence down to the western shore of the latter. All I could observe through my glasses, and what I had seen in 1906 from the other side of the mountain range, seemed to plead for the accuracy of the Kirghiz' information. My only regret was the impossibility of testing it on the spot. This, alas, would have necessitated my trespassing on His Afghan Majesty's territory. How often did I later on, too, look wistfully across the boundary drawn by the River Oxus with the fond wish that I might yet be allowed to pass "through the gate of favour" into those fascinating valleys and mountains on the Afghan side of the border, which I was now able to skirt for hundreds of miles!

Three rapid marches down the Great Pamir River then carried me to Langar-kisht, where we reached the main Oxus Valley (Figs. 25, 26), and the highest of the villages on the Russian side of the river. Here, too, everything was done by the Commandant of the Russian frontier post and the local Wakhi headmen to facilitate my journey. My subsequent journey down the Oxus was attended by an abundant harvest of observations bearing on the historical topography, archæology, and ethnography of Wakhan, which in early times had formed an important thoroughfare between Bactria, India, and the Central-Asian territories controlled by China. But it would cost too much time and space if I attempted here to give any details. It must suffice to mention that the exact survey of a series of ruined strongholds, some of them of very considerable extent, acquainted me with numerous features of distinct archæological interest in their plans, the construction and decoration of their bastioned walls, etc. (Fig. 28). The natural protection offered by unscaleable rock faces of spurs and ravines was always cleverly utilized in these defences. But some idea of the labour, which even thus their construction must have cost, can be formed from the fact that at one of these strongholds, known as Zamr-i-atish-parast,

the successive lines of walls, with their bastions and turrets solidly built in rough stone or in sun-dried brick, ascend the slopes of a precipitous spur over 1000 feet high, and have an extent of more than 3 miles.

It is certain that these hill fastnesses date back to pre-Muhammadan times and to a period when this portion of the Oxus Valley contained a population far denser than at present and enjoying a higher degree of material civilization. Their attribution by the present Wakhi people to the "Siahposh Kafirs" merely gives expression to a vague traditional recollection that they date back to times before the advent of Islam, the "Siahposh" of Kafiristan south of the Hindukush never having reached the stage of civilization which these ruins presuppose. Some architectural details seemed to suggest a period roughly corresponding to late Indo-Scythian or early Sassanian domination, during which our scanty records from Chinese sources indicate that Wakhan enjoyed a state of relative affluence and importance.

All along the big valley of Wakhan there opened glorious vistas to the south, where towering above narrow side valleys, and quite near, appeared magnificent ice-clad peaks of the Hindukush main range (Fig. 27), looking just as early Chinese pilgrims describe them, like peaks of jade. I realized now what an appropriate invention the "popular etymology" was, which in Muhammadan times has connected the old and much-discussed name of *Bolor*, vaguely used for the Hindukush region, with the Persian *billaur*, meaning crystal. The effect was much heightened by the unexpectedly verdant appearance which the cultivated portion of Wakhan still presented at that season, in spite of the elevation from 8000 to over 10,000 feet above sea-level, and doubly welcome after the bleak Pamirs. It was pleasant to note abundant evidence of how much the resources of the Wakhis on the Russian side of the valley had increased, both in respect of cattle and sheep and of land brought under cultivation, since annexation under the settlement arrived at by the Anglo-Russian Pamir Boundary Commission had removed all trouble from Kirghiz raids and Afghan exactions.

For all these reasons I felt glad that plentiful antiquarian and anthropometric work kept me busy in Wakhan during the first half of September. To this was added a philological task when, on entering that portion of the valley which adjoins the great northward end of the Oxus and is known as the tract of Ishkashim, I could collect linguistic specimens of the hitherto unrecorded *Ishkashmi*, one of the so-called Pamir dialects which form an important branch among the modern representatives of the Eastern Iranian language group. At the pretty little Russian post of Nut, which faces the main settlement of Ishkashim, I enjoyed the kind hospitality of Captain Tumanovich, its commandant, and benefited much by his local knowledge and help. Then I passed down the Oxus through the very confined portion of the valley known as Gharan, which until the recent construction of a bridle-path with Russian help was ground very difficult of access, even on foot, and visited Colonel Yagello's headquarters at Kharuk.

It lies at the fertile debouchure of the Shughnan valleys, where the cart road now crossing the Pamirs ends, and proved a very pleasant spot, boasting of fine fruit gardens, and to my surprise, even of electric light.

The relative abundance of fertile arable land and the facility of communication both with the Pamirs and the rich grazing uplands of Badakhshan have always given to the valleys of Shughnan a certain historical importance. They figure often in Chinese and early Muhammadan accounts of the Middle Oxus region. So I was glad to visit in succession the two main valleys of Shakh-darra and Ghund. Considering that the Shughni people have always been noted for their fondness for roaming abroad, in the old days as raiders, and are now as pedlars and servants to be found in all towns from Kabul to Farghana, it was interesting to observe how much of old-world inheritance in ethnic type, local customs, domestic architecture, and implements has survived among them.

From Shitam in the Ghund Valley I crossed by a distinctly difficult glacier pass, over 16,000 feet high, into Roshan. From the watershed, overlooking large and badly crevassed glaciers both to north and south (Fig. 6), I enjoyed a glorious vista over the rolling uplands of Badakhshan, a region towards which my eyes have been turned for many years, and to which access still remains closed. The narrow, deep-cut gorges in which the Roshan River has cut its way through towering mountain masses, wildly serrated above and very steep at their foot, proved a line of progress even more troublesome than the glaciers across which we had reached them. A two days' climbing and scrambling past precipices by narrow rock ledges and frail galleries (*awrinz*), as bad as any I ever saw in the Hindukush, was relieved in places by the use of skin-rafts, where the absence of dangerous cataracts allowed their employment. Guided by dexterous swimmers, they made me glide down over the tossing river, forgetful of all fatigue, in scenery of impressive grandeur, amidst rock-walls which ever seemed to close in upon us. But it was a real relief when the last rock gate was passed, and we emerged once more in the less-confined valley of the Oxus.

Roshan, just as it is the least accessible of all the side valleys of the Oxus, seems also to have preserved the *Homo alpinus* type of the Ghalchas in its greatest purity. The men, clean of limb and made wiry by constant movement over such impossible tracks, all showed clear-cut features, and often faces of almost classical regularity. The hamlets nestling at the mouth of the ravines were often half hidden amidst splendid orchards. The dwellings invariably showed plans and internal arrangements which were obviously derived from high antiquity, so many of the features being familiar to me from the architecture traced at early sites of Turkestan and the Indian North-West. Alpine seclusion seemed to have preserved here a small corner of the world scarcely touched by the change of ages, and I wondered whether some Bactrian Greek on a visit to Roshan would have

FIG. 27.—VIEW ACROSS OXUS VALLEY TOWARDS GLACIERS OF HINDUKUSH RANGE NEAR ISHMARG PASS.

FIG. 28.—WESTERN RAMPARTS OF KALA-I-KAKA STRONGHOLD, WITH VIEW DOWN OXUS VALLEY TOWARDS NAMADGUT.

seen much that was different from what these simple well-built dwellings show now.

After a busy delightful day's halt at Kala-Wamar, in the garden of the ruined castle of the Shughnan chiefs, I crossed the glacier pass of Adude and made my way into the Yazghulam and Vanj valleys of Darwaz, where the territory of the Amir of Bokhara was entered. Here, too, the recommendation of the Imperial Russian political representative, Consul Belaieff, had assured me all possible attention and help. As I travelled up the Vanj Valley, and subsequently through the mountain tract known as Wakhia-bala, I could well observe the gradual change in the physical appearance, houses, ways of living, etc., of the people, bearing testimony to the historically attested conquest of Turki tribes and the influence exercised by the civilization of the Turkestan plains. But we were still high up in the mountains, and had a trying task when on October 3 we crossed the Sitargh Pass, *circ.* 14,600 feet high, with its big and badly crevassed glacier, after the first winter snow had fallen, and just in time before it became closed to traffic. Finally, we gained by the Gardan-i-kaftar Pass, also under fresh snow, the main valley of Kara-tegin.

Here on the banks of the Kizil-su River, coming from the Alai, I found myself once more on the line of the ancient silk-trade route connecting China with Bactria. A marked change in the climatic conditions was brought home to me by the fact that the fertile slopes on the hillsides are being cultivated without the need of irrigation. Kara-tegin, as its modern name attests, had been long occupied by a Turki-speaking population. It was interesting to note here how the Kirghiz settlers, who represent probably the last wave of this Turkish invasion in what was originally Iranian ground, are now being slowly ousted again from the land by a steady reflux of Tajik immigrants.

From Kara-tegin, where I had interesting opportunities for getting to know the traditional administrative methods of Bokhara, a succession of rapid marches carried me westwards through the open and remarkably fertile valleys which the rivers of Kafirnihan and Surkhan drain. It seemed hard to forego a visit south to the Oxus, where it passes nearest to my old goal of Balkh or Bactra. But time was getting short for the remaining portion of my programme. So I took the nearest route to the confines of ancient Sogdiana north-westwards by the difficult track through the mountains which connects Hissar and Regak with the rich plains about Shahr-i-sabz. Finally, on October 22, I arrived at Samarkand and the Russian Central-Asian railway. Since the start from my camp in the Kashgar Mountains my journey had lasted just over three months, and within these we had covered on foot and on horseback an aggregate marching distance of close on 1700 miles.

A new and distant field of work lay ahead for me on Persian soil. So only a few days could be spared for renewed visits to the great monuments of Muhammadan art and Mughal power at Samarkand. It was the same at

Bokhara, where I could personally thank M. Shulga, then officiating as the Imperial Russian representative, as well as the Diwan-begi, the head of H.H. the Amir of Bokhara's administration, for all the kind help and hospitality I had received in the State. So much survives, in that fascinating great city, of old-world Central-Asian life and of its own historical past that my three days' stay seemed a sadly brief time. Then the Trans-Caspian railway carried me to Askhabad, the great Russian cantonment on the Persian border, and crossing this I reached Meshed by November 4 after a four days' hard drive.

There, at the old capital of Khorasan, Colonel T. W. Haig, H.B.M.'s Consul-General for Khorasan, and a distinguished Oriental scholar, offered me the kindest welcome and the chance of a much-needed short rest. Under the hospitable roof of the Consulate and within its fine large garden I felt as if brought back to some English country house. Constant toil at much-delayed official accounts kept me busy and, alas, left little time for glimpses of the interesting city outside. Seistan was my goal for the winter's work, and considering its great distance and the uncertain state of political affairs in Persia, I had much reason to feel grateful for the kind help and shrewd advice by which Colonel Haig facilitated my rapid onward journey.

On November 11 I left Meshed for Seistan. In order to reach it I had chosen a route which, keeping off the main roads, gave opportunities for useful supplementary survey work and offered the further advantage of being the most direct (Fig. 30). It first took us by little-frequented tracks through hills held by Hazara and Baluch tribal settlements to Rui-Khaf. Thence we travelled south in an almost straight line parallel to the Perso-Afghan border, where it passes through a nearly unbroken succession of desert depressions and of equally barren hill ranges. Near a few of the little oases we passed, as at Mujnabad, Tabbas, and Duruh, I was able to examine remains of sites abandoned since early Muhammadan times. At Bandan we struck the high-road, and two days later, on December 1, reached Nasratabad, the Seistan "capital." The excellent Persian mules hired at Meshed had allowed us to cover the total distance of over 500 miles in nineteen marches. With the assistance of Afrazgul Khan a careful plane-table survey on the scale of 4 miles to 1 inch was carried over the whole ground. The disturbed conditions of Persia due to the war made themselves felt also on the Khorasan border, ever a happy raiding-ground for enterprising neighbours. But owing, perhaps, to the rapidity of our movements and the unfrequented route chosen, the journey passed off without any awkward encounters.

Once safely arrived in Seistan I received a very kind and hospitable welcome from Major F. B. Prideaux, H.B.M.'s Consul in Seistan, and could quickly set to work with all the advantages which his most effective help and prolonged local experience assured me. Ever since my student days I had felt drawn to Seistan by special interests connected

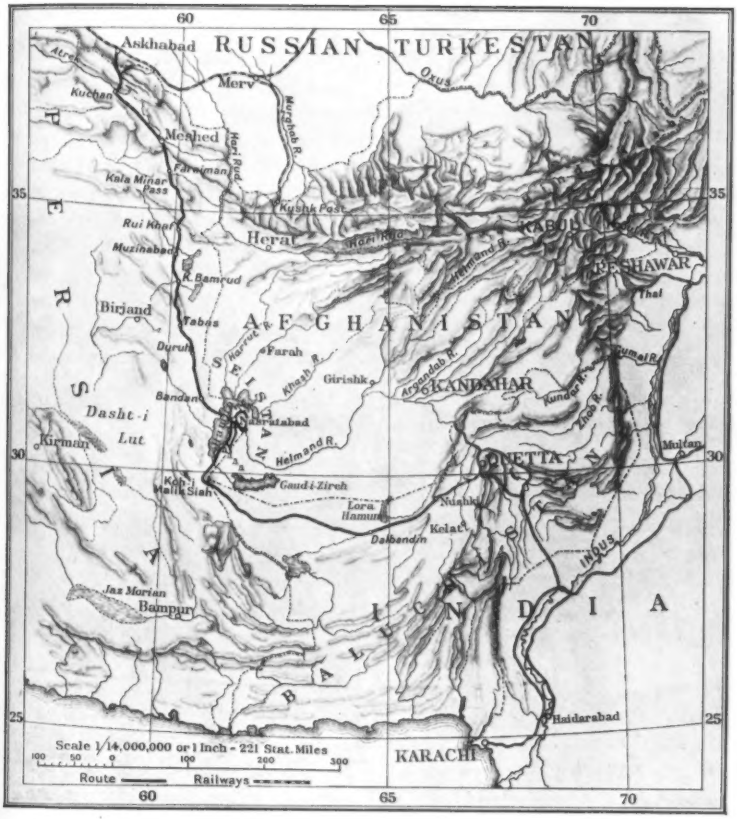

FIG. 30.—SKETCH-MAP SHOWING THE ROUTES FOLLOWED BY SIR AUREL STEIN THROUGH KHORASAN AND BALUCHISTAN.

FIG. 31.—LOWER GATE AND TERRACES ON EAST SLOPE OF RUINED SITE, KOH-I-KHWAJA HILL, SEISTAN.

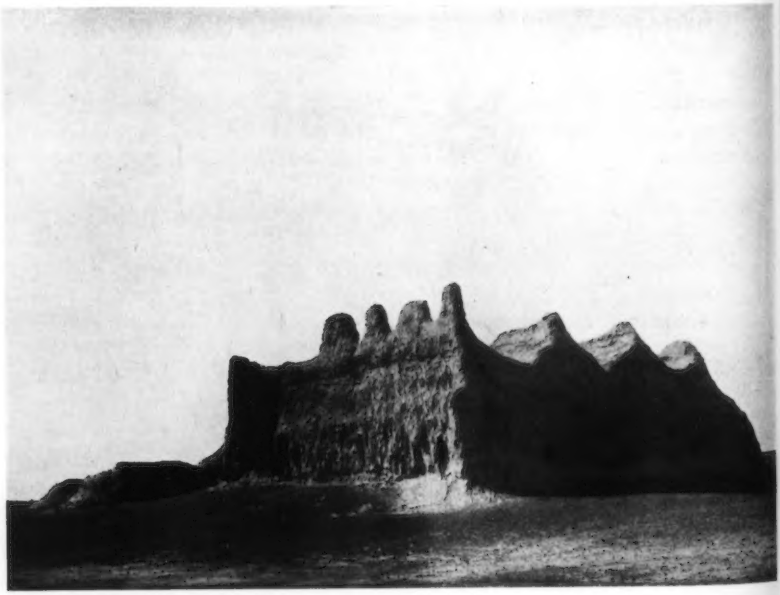

FIG. 32.—ANCIENT FORTIFIED WATCH STATION, SEEN FROM NORTH-EAST, IN DESERT SOUTH OF SEISTAN OASIS.

with its geography and historical past. It had been more than chance that my very first paper, published as long ago as 1885, dealt with the ancient river names of this Iranian border-land. My present visit to Seistan, long deferred as it was, could for various reasons be only a kind of reconnaissance. Yet even thus I might hope among its numerous ruined sites to discover remains of the early periods when ancient *Sacastana*, "the land of the Sakas or Scythians," served as an outpost of Iran and the Hellenistic Near East towards Buddhist India. A strong additional reason was provided by my explorations in the Tarim Basin; for the striking analogy presented by various physical features of the terminal basin of the Helmand River was likely to throw light on more than one geographical question connected with the dried-up Lop Sea and the ancient Lou-lan delta.

It is a great satisfaction to me that in both directions my hopes have been fully justified by the results of my Seistan work. But it is only the most prominent that I can find space to record here in brief outlines. At the very start my archæological search was rewarded by an important discovery. It was made on the isolated rocky hill of the Koh-i-Khwaja, which rises as a conspicuous landmark above the central portion of the Hamuns or terminal marshes of the Helmand. The extensive and well-known ruins situated on its eastern slope (Figs. 29, 31) proved to be the remains of a large Buddhist sanctuary, the first ever traced on Iranian soil. Hidden behind later masonry, there came to light remarkable fresco remains, dating back undoubtedly to the Sassanian period. Wall paintings, of a distinctly Hellenistic style and probably older, were found on the wall of a gallery below the high terrace bearing the main shrine. Protected in a similar way from the ravages of man and atmospheric moisture they had unfortunately suffered much from white ants. The importance of these pictorial relics, which I managed to remove safely in spite of various difficulties, is great. They illustrate for the first time *in situ* the Iranian link of the chain which, long surmised by conjecture, connects the Græco-Buddhist art of the extreme north-west of India with the Buddhist art of Central Asia and the Far East. This connection was reflected with equal clearness by the architectural features of the ruins, which were also of great interest.

In the desert south of the present cultivated area we found interesting remains of far earlier times. My search here was greatly facilitated by the excellent topographical surveys on a large scale which had been effected under the direction of Mr. G. P. Tate, of the Survey of India, in connection with Sir Henry McMahon's Seistan Mission of 1902–05, and which proved very helpful also in other parts. On this desert ground which an abandoned old branch of the Helmand had once watered, excessive wind-erosion acting on alluvial clay had produced conditions exactly corresponding to those I had found in the dried-up delta north of Lop-nor. Since moisture and vegetation had deserted this soil, the

scouring effect of the sand driven by the north wind that blows over Seistan with more or less violence, but almost constantly during four months of spring and summer, had lowered the level of the ground to varying depths, down to 20 feet or more, below the original level, except where the surface had been protected by hard débris of some kind. The erosion terraces thus left rising island-like above the bare plain were always found thickly covered with prehistoric remains. They consisted of potsherds, often decorated in colours, and stone implements mainly of the Neolithic period, but in places included also relics of the Bronze Age. It was easy to pick up here an abundant archæological harvest literally on the surface.

It was a very interesting and quite unexpected discovery when in the same area I came upon the remains of a close line of ancient watch-stations, stretching right across the desert from the southernmost Hamun in the direction of the true terminal basin of the Helmand, the marsh and lake-bed of the Gaud-i-Zirreh. It was a fascinating task to trace this Seistan *Limes*, and the experience gained during my explorations along the ancient Chinese border-line once protecting the extreme north-west of Kansu helped me greatly. The fortified frontier posts (Fig. 32), solidly built with bricks of great size on a uniform plan, and, as it were, to "specification," were found always to occupy erosion terraces retaining prehistoric pottery débris. Chosen, no doubt, for the sake of increased command of ground and wider outlook, these elevated positions had helped also to save the ruins from complete destruction by the erosive force of wind and sand. The watch-stations were found at distances from half to about $1\frac{1}{2}$ miles apart. The position of sectional headquarters could also be identified by additional structures, etc.

Seistan, in spite of its dreary arid look, does not enjoy a climate quite sufficiently "desiccated" for archæological purposes, as it still receives a fairly regular rainfall of *circ.* 2 inches per annum. So the refuse heaps at these stations, which might have furnished us with interesting dateable records, were found to have decayed into mere odorous layers of earth. But a variety of archæological finds and observations pointed to centuries near the commencement of our era, as the time when this ancient border-line was established. Its object was clearly to protect the cultivated portion of the Helmand delta against raids of nomadic tribes in the south, corresponding in character and habits, if not in race too, to the present Baluch and Brahui tribes to be found there. I cannot indicate here in detail the curious points of analogy presented to the ancient Chinese frontier line of Kansu constructed *circ.* 100 B.C. against Hun raids from Turkestan. But I may hint at least at an interesting question which suggests itself in view of the geographical position. Would one be justified in regarding this fortified desert border of Seistan as a link between that ancient "Chinese Wall" in the desert and the *Limes* lines by which Imperial Rome guarded its marches in Syria and elsewhere in the Near

East against barbarian inroads? Only from future researches can we hope for a safe answer.

From these desert surveys I returned to the inhabited portion of Persian Seistan by the beginning of January 1916, and was kept busy during a few weeks with the examination of the numerous ruins surviving there. Almost all proved of mediæval Muhammadan origin or even more recent, a fact which the physical conditions of the present Helmand delta easily account for. At two sites, however, which their high level has protected from the effects of irrigation or periodic inundation, I discovered definite archæological evidence of ancient occupation. At the large ruined stronghold known as Shahristan, occupying a high alluvial terrace, this included pottery fragments inscribed in early Aramaic characters.

I should have much liked to visit the Afghan portion of Seistan, to the north of the Helmand, where Sir Henry McMahon's Mission and earlier travellers had found a large number of ruins still awaiting expert examination. Permission for such a visit could, however, not be secured, and I did not feel altogether surprised at it. So, after collecting useful anthropometric materials which help to illustrate the curious mixture of races in the population of Seistan, I returned to the desert south and supplemented my survey of the ancient *Limes* by some rapid excavations. They disclosed interesting details as to the construction and internal arrangements of those ruined watch-stations and the life once led there.

Thence I set out by the beginning of last February for the return journey to India, whither most of my archæological finds from Seistan, filling twelve cases, had already preceded me. I travelled by the Seistan-Nushki trade route which the zeal of Captain (now Colonel) F. Webb Ware, of the Indian Political Department, had first pioneered through the desert some twenty years ago. Well known as the route is, this desert journey of close on 500 miles through the wastes of Baluchistan had for me a special interest. I could not have wished for a better modern illustration of the conditions once prevailing on that ancient route through the Lop desert, which the Chinese had opened about 110 B.C. for the expansion of their trade and political influence westwards, and which two years before I succeeded in tracking through those waterless wastes after sixteen centuries of abandonment.

It is true that wells of tolerably good water at most of the stages, comfortable rest-houses at all, and good camel grazing to be found at half a dozen points, made progress along this modern desert track seem child's play compared with what we had gone through. Even in ancient times the physical difficulties successfully overcome by those early Chinese pioneers must have been vastly greater than those which the route to Seistan ever presented in the days before its improvement. And yet the latter, by the political reasons which have necessitated its opening, by its purpose, by the character of the traffic I found moving along it,

provided a most striking analogy, and neither as a geographer nor as a historical student could I fail to appreciate its significance.

By February 21 I reached Nushki, whence the railway carried me to Delhi. During my week's stay at the Indian capital I received fresh proof of the kind personal interest with which His Excellency the Viceroy, Lord Hardinge, had from the start followed and encouraged my enterprise. There, too, I was able to meet again some of my oldest friends in India, to whom I had never appealed in vain for such official support as they could give to my scientific labours. A subsequent brief visit to Dehra Dun, the Survey of India headquarters, enabled me to arrange for the suitable publication of the topographical results brought back from this journey, in an atlas of maps. At the same time I secured the admission of Afrazgul Khan to the Survey Department's service under conditions which open up to this capable young assistant the amply deserved prospects of a good career. When I subsequently paid a brief visit to H.H. Sir Michael O'Dwyer, the Lieutenant-Governor of the Punjab, at Lahore, I had the great satisfaction of learning from this kind old friend that the splendid services which R. B. Lal Singh had rendered to Government for a lifetime were to be recognized by a grant of land on one of the new Punjab canals. It meant the realization of my devoted old travel companion's most cherished hope, and a reward such as I had always wished to secure for him. Finally, after the middle of March I reached Srinagar, in Kashmir, my favourite base, from which my expedition had been begun in July 1913. It had lasted close on two years and eight months, and the aggregate of the distances covered by my marches amounted to nearly 11,000 miles.

At Srinagar the 182 cases of my collection of antiquities from Turkestan had safely arrived by October, and there the greatest part of the work demanded by its arrangement and detailed examination will have to be done with the expert help of my old friend and collaborator, Mr. F. H. Andrews, now Director of the Technical Institute and Industrial Art School of the Kashmir State.

The elucidation of the antiquities brought to light by the thousand, and in such great variety of place, time, and character, will involve heavy and manifold labours, and for them and the proper decipherment of the abundant manuscript remains, recovered in about a dozen of different scripts and languages, the help of quite a staff of expert scholars will be needed. The Government of India, though intending that the whole of my collection shall ultimately be deposited in the new museum planned at Delhi, fully realized that this expert help can for the most part be secured only in this country and in France, where after my former expedition, too, I had found the most helpful and important of my collaborators. So I was given permission temporarily to bring here whatever materials stood in need of specialist examination and research, and to come myself to England for a time to make all necessary arrangements in

person. But after all the efforts and toils it has cost to recover those relics of past ages from their safe resting-places in the desert it would have obviously been unwise to expose a great and valuable portion of them to the grave risks to be faced at present on a long sea voyage round the shores of Europe. So I decided to transfer myself only across the seas, and to use a short rest in England for preparing a preliminary record of the results achieved and for organizing well in advance the work of my future collaborators.

After two years of the greatest struggle which the history of mankind has known I returned to England fully prepared for considerable changes, and I found such, some sad, some reassuring and hopeful. But no change has affected the kind interest shown in my scientific efforts by old friends within the Royal Geographical Society and outside, and the encouragement derived from this boon I shall ever remember with gratitude.

Before the paper the PRESIDENT said: Our business this evening is to welcome Sir Aurel Stein, one of our most distinguished Asiatic travellers, on his return from his third journey to the heart of Asia. He needs no introduction here. We have heard him more than once in this hall, and we know how much he has done, not only as a geographer, as a cartographer, as a surveyor, but also as an archæologist. We know that his travels have led him to one of the most interesting regions on the Earth's surface, where from times long before the beginning of our era the trade to and from Europe and the Nearer East crossed the Chinese frontier. Sir Aurel Stein has got so much to tell us that I am sure the best thing I can do is to ask him at once to begin his discourse.

(*Sir Aurel Stein then read the paper printed above and a discussion followed.*)

Mr. AUSTEN CHAMBERLAIN: When I came here to-night as the guest of one of your members, and even when on entering this building you expressed a desire that I should say a few words in the course of the evening, I did not quite understand the position of prominence which you intended to allocate to me, and I am afraid that I am wholly unfitted for it. I am not a Fellow of your Society, and I am afraid if any geographical knowledge, let alone any geographical exploration, is necessary to qualify for that position, I shall never attain to it. My recollections of geography are of a painful study which, laboriously acquired, was inevitably quickly forgotten; a study of maps of which most were already too full, and which it is the business of your Society to crowd with still more details. You and perhaps the audience will feel that these confessions hardly indicate my fitness for my present position; but at least I am trying to improve. I had the pleasure of welcoming Sir Aurel Stein at the India Office in virtue of the position I hold there, and though I learned very little from him in the brief and very modest account which he gave me of his travels, it was at any rate sufficient to make me feel the importance of the work which he had done, and the immense interests of the results which he had achieved. I think I may fairly say—for I had nothing to do with his travels at any stage—that he was fortunate in the collaboration of the representatives of two Governments. He had the good will of the Government of India, and, as we are glad to recognize, he enjoyed equally the good will of the Russian authorities. By their aid, and above all by his own indomitable

perseverance, his courage, his endurance, and his enthusiasm, he has achieved results which are of interest to all of us, which are of importance to the Governments of India and of Russia, and which, I venture to add, will serve to confirm the high reputation which he has won among explorers. I am not fitted to initiate a discussion of the kind you have invited. I am glad to pay my tribute —and to pay my tribute as Secretary of State for India—to what Sir Aurel Stein has done; but for a learned discussion of his work you must turn to other and greater authorities.

The PRESIDENT: Mr. Austen Chamberlain has alluded to one of the happiest points in the explorations of Sir Aurel Stein—that they constitute a new link in the friendship between the two great Empires that share the larger part of Asia, England and Russia. We are happy in having here to-night the distinguished Russian officer General Baron Kaulbars. I do not know if he would be kind enough to say a few words to us.

(*General Baron Kaulbars bowed his acknowledgments.*)

Sir HERCULES READ: I am personally very glad to say a few words in order to bear my small testimony to the extraordinary qualities that my old friend Sir Aurel Stein has brought to bear upon the varied aspects of the journey that he has just described to us. I know nobody among all the explorers whom I have met who has greater capacity for carrying on archæological and geographical work under conditions that we all can imagine, after having seen that beautiful series of slides he has put before us. In the intervals of extremely tedious marches he has devoted himself to archæological research in temperatures and climates which are very trying, and, as in former years, he has brought home a collection of antiquarian remains which have opened up fresh fields to archæologists in these islands. For this we who perforce remain at home are most grateful, and not only to Sir Aurel Stein, but in a very great degree to the authorities at the India Office. The atmosphere at this meeting is naturally a geographical one, and I feel that the importation of archæological questions is somewhat of an intrusion; but I can speak only about my own business. Sir Aurel Stein has given us from time to time a *résumé* of his geographical discoveries, using archæology, if I may say so, as a series of signposts; and very useful he has found it, as he has confessed. But when one considers that he begins with the Palæolithic period, which you may put back to any remote date, and comes up to something like the seventh or eighth century, and that we have withal not one single piece of these antiquarian remains before us, it is somewhat hopeless to discuss the archæological questions at present. When these remains come to Europe to be studied they will be distributed amongst a number of distinguished scholars, and will then go back to the central Indian Museum which is to be established at Delhi. That, I am sure, is a very proper place for them. I have myself taken considerable interest in the Museum, and have gladly given advice on certain administrative points regarding it; but a difficulty I find as an archæologist, domiciled in England and incapable of leaving it for more than a few months, is that there will be no opportunity for European students ever to consult these antiquities, except for those fortunate ones who are able to go anywhere at any time and for as long as they please. Sir Aurel Stein's first antiquarian results were divided between the Government of India and the British Museum. There is no difficulty therefore to some extent in still seeing in England the type of object that was discovered on the first expedition. With regard to the later expeditions the case is different, and I think presents a difficulty for the people living in the British Islands of judging the culture that belongs to Central Asia, to these ancient civilizations,

dating from a century or two before our era to several centuries afterwards. Beyond the small collections to be found in Paris, nowhere in Europe will any of these remains be seen. It seems to me a pity that these objects of extraordinary interest, covering almost all periods of human activity and human industry, are not to be represented at all in these islands. I think that some measures should be taken by which adequate representations of these very interesting historical and religious remains should find their place somewhere within reach of the ordinary British citizen.

Sir FRANCIS YOUNGHUSBAND: As a traveller in both Chinese Turkestan and also on the Pamirs I can testify to the splendid exploit of our lecturer this evening. I know well the hardships he must have gone through and the indomitable courage which actuated him in carrying out these explorations. Since the time of the great Russian, General Prjevalsky, there has been no traveller in Central Asia who has shown so great a persistence over such a large number of years, and such courage and determination in carrying out his explorations, or has brought back such fruitful results, as Sir Aurel Stein. I wish to congratulate him most sincerely on his magnificent achievement.

Sir HENRY TROTTER: Some years ago I had the pleasure on the occasion of Sir Aurel Stein's last lecture before the Society of congratulating him on the success of his work, and I laid particular stress upon the magnetic influence by which he seemed to attract such very different persons as the Trustees of the British Museum, the Viceroy of India, the *personnel* with whom he worked, and last but not least the Taoshih of the Temple of the Thousand Buddhas. It is gratifying to note that he has by no means lost that magnetic power, as is proved by the record of his journey, the splendid work of his surveyor Lal Singh, and the excellent reception of the lecturer by the Russian and other authorities with whom he came in contact.

I should have liked to have made some remarks on a good many points [see note following the discussion], but the lateness of the hour prevents me from doing so. I will only take up your time with one. I was in Central Asia forty-three years ago and know many parts of the ground described by Sir Aurel. The point to which I wish to refer is the great problem as to the principal source of the Oxus River.

Lord Curzon a good many years ago gave in this hall an account of his travels in the Pamirs, and of his discovery in the mountains of Kanjud of a glacier from which flowed a river that, as he maintained, was the principal source of the Oxus. As a result of my own previous observations I (in common with some Russian geographers) looked upon the Little Pamir Lake, also fed by glaciers, as the principal source. From the lake a river, the Aksu, flows eastward, then north, and then north-west as the Murghabi, and later on as the Bartang River, which joins the Panjah branch of the Oxus a few miles above Kila Wamar, where the river makes a great branch to the west.

Lord Curzon maintained that his (*i.e.* the Panjah) branch was the more considerable of the two. I adduced the testimony of an Indian native surveyor who had visited the spot and clearly proved that the Bartang River at the time he visited it had a much greater flow of water than the Panjah; but Lord Curzon produced the testimony of a reliable European witness to prove that when he visited it, at another season of the year, the Panjah branch contained much more water than the Bartang. Both statements were probably true; but for my part I stuck to my theory. I regret that the lecturer has told us this evening that the Bartang River has now been completely blocked up from the effects of an earthquake, that a large lake has been formed, and that it is

unlikely that any water will flow down the Bartang into the Oxus for many years to come. So at last I must confess myself vanquished.

Colonel C. E. YATE: I am delighted to add any words I can to congratulate Sir Aurel Stein on his return. We have all watched the news that has been received from him from time to time with the greatest interest, and are delighted to see him back here again. We are looking forward to seeing the results of his finds displayed here as soon as the roads are safe. As to what has just been said regarding the final disposition of the treasures I too think that a certain amount should remain in this country, and all should not be taken back to India. It seems to me a fair thing to leave some part at any rate for show in this country. I cannot see any reason why all should be taken back to Delhi, as I understand from Sir Hercules Read is the present intention. I congratulate Sir Aurel Stein most heartily on his journey, and we all join in thanking him for the paper he has given us.

Dr. BARNETT: I well remember seven years ago when this Society met to hear Sir Aurel Stein's report of his second expedition and expressed appreciation of his work. It was felt that Sir Aurel Stein had added not only great areas to the Trigonometrical Survey, but even greater realms to knowledge. Further study has confirmed that view, because we have found in result that his second journey was rich to an almost inconceivable degree. His archæological discoveries throw enormous light on the ancient history of that important region which he has covered, and his literary documents have opened up new areas of literature. Similarly, his ethnological studies have been fruitful. Now Sir Aurel Stein, with his usual habit of eclipsing himself, has returned from a third expedition that has exceeded his former ones in importance, inasmuch as he has nearly doubled the net archæological proceeds of the last. From the second journey he came home with 96 cases; now he has 182, after having traversed nearly 11,000 miles. I have no doubt that, in the same way as his previous journey was epoch-making in many ways, so the results of this journey will be equally epoch-making, and I feel sure that this Society in honouring him is doing honour to itself.

The PRESIDENT: At this what Dr. Mill would call "fraudulently late hour of the evening" I will not keep you longer, but I am sure you will wish me to say a few words of most hearty thanks to Sir Aurel Stein for the very brilliant and exhaustive account he has given us of his labours in these barren and difficult regions of Central Asia—labours that are double-sided in a way I think few travellers' have been. The manner in which he first rushes over a series of glacier passes—and so many of them that I believe they would have given even the Alpine Club a surfeit—and then turns to explore buried cities and study the civilization of two thousand years ago is almost unique. We owe, I hold, special gratitude to travellers who go to the very ugly places of the Earth. It is a great temptation to most of us to go only to the beautiful places. When we see those pictures of interminable sand-dunes and rocky hummocks torn asunder and laid bare by the most cruel winds, we feel that the man who for the sake of geographical knowledge and archæology would linger among them deserves a double meed of thanks. The results are extremely interesting, because we find that these desert-places once maintained a great population. This fact opens up many subjects of inquiry, historical, meteorological, changes of climate, migrations of peoples. We also find this charm in these particular trade-routes, that they were the old trade routes between Greeks and Romans and the farthest East. Sir Aurel Stein tells me that in those days the trade caravans must have gone not over the easiest routes but over hundreds of miles of desert in order to

avoid the marauding tribes who were living where there was some possibility of human beings living happily.

We have followed, perhaps with some difficulty owing to its very complexity and richness, the account of his labours put forward by Sir Aurel Stein. We shall all read it with the deepest interest when published in our *Journal*, and we may hope that it will not be published without specimens of the appropriate illustrations which we have admired to-night. The perseverance with which Sir Aurel Stein photographed as he went along is, even in these days of photography, deserving of the highest praise. I will say no more, but offer to him the very hearty thanks of this meeting and all geographers in this country and the rest of Europe—except perhaps in Berlin, where they may grudge him some of his Buddhist frescoes; I am sure his reputation over Europe as one of the greatest travellers of modern times is now firmly established. Three times we have seen him here and each time he comes back with a richer harvest than he did the time before.

Sir Henry Trotter has kindly sent the following additional note for publication:—

I at one time took considerable interest in the geography of the Oxus below Kila Wamar. In the spring of 1874, when leaving Wakhan to return to India, I despatched the Munshi Abdul Subhan (an employé of the Survey of India) to follow the course of the river from Kila Panjah to Roshan and Shighnan. The account of his journey was published in the R.G.S. *Journal*, vol. 48, pp. 210–217. He followed the course of the river for 60 miles from Kila Panjah to Ishkashim, where turning northwards he followed the Oxus for nearly 100 miles further, passing successively through the districts of Gharan, Shighnan, and Roshan—countries which had hitherto only been known to us by name. He could not penetrate beyond Kila Wamar, the chief town of Roshan; but curiously enough another employé of the Survey, "The Havildar," who had been dispatched by the late General Walker from India in 1873 on an independent exploration, went from Kabul to Faizabad, the capital of Badakhshan, and thence started on a tour which combined with the Munshi's exploration to Kila Wamar entirely altered the map of that hitherto little-known portion of Central Asia. He visited the towns of Kolab, Khawaling, Sagri Dasht, Kila Khum (the capital of Darwaz), Kila Wanj, and Yaz-Ghulam. At Kila Khum the Havildar struck the Oxus (still called the Panjah), and his road for 40 miles lay on the right bank of the river—never previously mapped or, as far as I know, visited by any explorer. At Yaz-Ghulam, the eastern frontier village of Darwaz, he was unfortunately turned back—just as he had got within a long day's march of the Munshi's farthest point at Kila Wamar. The Havildar, who was ignorant of what the Munshi had done only a few weeks previously to his own arrival at Yaz-Ghulam, was most anxious to complete his own work. In order to do so he went back by Kolab to Ishkashim, and endeavoured to make a survey down the river to Yaz-Ghulam; but he was again stopped, this time at the southern frontier of Shighnan, and was prevented from carrying out his intentions. Thus there was a gap between the explorations of the Havildar and the Munshi, the existence of which was much regretted; fortunately the missing link was a short one—some 20 miles as the crow flies. A Russian scientific mission visited these parts ten years later, in 1883; but the map then compiled differs greatly from their latest published map of 1910, which again differs from an intermediate map published in 1900. I fancy that accurate surveys of these little-known countries have still to be made.

A SYNTHETIC METHOD OF DETERMINING GEOGRAPHICAL REGIONS.

J. F. Unstead, M.A., D.Sc.

Read at the Afternoon Meeting of the Society, 17 *February* 1916.

IT is now more than ten years since Prof. Herbertson read before the Research Department of this Society his paper on "The Major Natural Regions: an Essay in Systematic Geography" (published in the *Geogr. Journ.*, March 1905). The discussion which followed the paper showed that the main ideas were scarcely realized at the time, and the criticisms of them which were then expressed stand in strong contrast with the wide acceptation which they have since received. There can be no question that the idea of natural regions, each with certain characteristics proclaiming its essential unity and having close similarities to other regions on the globe, has already been of considerable value and is one that must be part of the equipment of all geographers and students of geography.

The untimely death of Prof. Herbertson has cut short the research which he was still pursuing upon this subject, and it remains for others to continue his work and to build upon the foundations which he laid.

During the last few years several attempts have been made to divide the world into "major natural regions" on much the same lines as Prof. Herbertson indicated, and a comparison of these attempts has led me to the conclusion that the methods hitherto adopted might with advantage be considerably extended in some directions and modified in others. Such reconsideration of his methods was indeed welcomed by Prof. Herbertson both in his published papers and in private conversation; the great regret of us all is that he is not here to take part in this discussion and illuminate the matter with his wide knowledge and experience.

The first map of the world dividing it into natural regions and grouping these into types was that published by Prof. Herbertson in 1905 (*Geogr. Journ.*, March 1905); the second (as far as I am aware) was drawn by Miss Taylor and myself in 1910 ('General and Regional Geography,' London, 1910); the third was that of Prof. Dryer, published in 1911 ('High School Geography,' New York, 1911); the fourth was a revision by Prof. Herbertson of his earlier map, and was published in his paper on "The Higher Units" in 1913 (*Scientia*, Bologna and London, 1913): it will be convenient to refer to these as the maps of 1905, 1910, 1911, and 1913 respectively.

Certain common features of these maps seem to me to be open to criticism. For example, all the maps agree in grouping the north-western coastal region of North America with the north-western region of Europe; this is done in the 1905, 1910, and 1913 maps by classifying the two areas in the same group, while the 1911 map makes a subdivision in each case, grouping the coast of Alaska and British Columbia with Northern Scotland

and Norway, and the coasts of Oregon and Washington with the south of the British Isles and the greater part of France and Germany. The question arises: In what respects are these grouped regions alike and in what respects are they different? They are alike in their climate; they are different in their geological structure and their surface configuration, in their accessibility from other regions, in the natural resources they offer to occupation by man, and, consequently, and very markedly, in economic conditions, density of population and political importance. In the broadest geographical sense they may be considered unlike rather than similar.

Moreover, all the maps agree in putting North-Western Europe into a different class from the region between Newfoundland and the Northern Appalachians in the vicinity of the Potomac, and yet in most particulars the regions resemble one another. The winter temperatures are indeed dissimilar, so that the northern part of the American region is ice-bound, whereas the European region has open waters, but the summer temperatures are not widely different and make possible the same agricultural products. The precipitation is similar, with the exception that in the American region it more often takes the form of snow, and the natural vegetation is therefore closely comparable. Structurally the regions are very alike, so that the relief, in the matters of the proportion of highland and lowland and the types of the land-forms, shows a fairly close relationship, while the northern part of each area bears the marks of relatively recent glaciation.

The mineral resources may also be compared, and the great coal deposits are the bases of manufacturing industries which characterize a considerable portion of each region and have in certain parts even transformed their appearance. The agriculture of large areas, the fishing industries on the submerged banks of the more northern parts, and the commerce of the more southern portions, with the necessary close network of communications, may all be regarded as further indications of their essential similarity.

Finally, the position of the regions, facing one another on opposite sides of the Atlantic Ocean, is a factor which cannot be omitted in a survey of their characteristics, bringing them closely into touch with each other and making them almost equally accessible by water from the other parts of the globe. The parallels between particular districts, *e.g.* Scotland and Nova Scotia, can be drawn to a truly remarkable degree of exactitude.

Again, in all the maps except that of 1911, India and Indo-China are grouped with the northern part of Australia; these regions have indeed similar physical conditions, but they offer the most marked contrasts in regard to their human geography. This raises the question of the meaning of the term "natural regions"; is it intended to relate only to natural, in the sense of physical, conditions, or to indicate the regions which are marked out by natural, as distinct from artificial, boundaries?

The paper explaining the 1905 map states: "A natural region should have a certain unity of configuration, climate, and vegetation. . . . The map-

ping of human conditions has less significance in indicating the natural geographical regions, for the factor of human development has to be taken into account as well as the possibilities of the natural environment. . . . Political divisions, expressing the most complex and comparatively unstable of human conditions, must be eliminated from any consideration of natural regions."

It thus appears that the map was intended to be based mainly but not entirely upon physical considerations; yet the writer used the term "natural geographical regions," and elsewhere he defined the subject-matter which he wished to systematize as "definite areas of the surface of the Earth considered as a whole, not the configuration alone, but the complex of land, water, air, plant, animal, and man, regarded in their special relationship as together constituting a definite characteristic portion of the Earth's surface." If the latter phrase defines the subject-matter of geography, the regions as delimited on the map may be termed natural in the sense of physical regions, but they are not geographical regions, for they take but little account of the living inhabitants of the Earth's surface. The revised map of 1913 gives no more weight to the non-physical conditions, although the text emphasizes the fact that geography is concerned with the interrelations of *all* the elements in the great "macro-organism" of the Earth.

The 1910 map is introduced by the sentence: "In dividing the world into natural regions it is necessary to consider only those outstanding differences of relief, climate, and natural resources which have the most marked influence upon the development and activities of man." Here the term "natural resources" is one which may have a wider denotation than the elements considered in the first map, but it is still merely the environment of man that is considered.

Similarly, the 1911 map deals with the environment and not the human conditions, although its context suggests that the term "natural" is employed in contradistinction to "artificial," and that the various environments "derive their greatest importance in geography from their relations to human affairs."

Moreover, examining only the maps themselves one would conclude that relief and climate were by far the most important considerations in the minds of the compilers, and that other factors, *e.g.* natural resources, were considered rather as the results of these two fundamental conditions than as of independent and equal importance.

My contention is that in all cases the division has been carried out on far too narrow a basis; that although "physical," or so-called "natural," regions may be thus obtained, a wider view must be taken, a more extensive and more careful survey must be made, before the regions can be regarded as "geographical," and that there is a need for a division of the world into truly geographical regions.

The suggestion might be advanced that without departing from the idea of dealing with the environment of man, the work would be better

based if greater weight were given to the element of structure. A map of the "structural divisions" of the world was indeed published with the 1905 paper, but apparently little used. It would serve to differentiate North-Western Europe from the north-western coastal region of North America, for they belong to structural divisions of a totally different type, while North-Western Europe is in this respect almost exactly comparable with the region lying upon the opposite side of the Atlantic Ocean. What, then, would be the consequences of admitting structure to a higher place among the determining factors of the regions? On the one hand, it would ensure a greater similarity in regard to land-forms and mineral deposits, which either actually or potentially affect the modern economic development of a region to a considerable degree. On the other hand, it would alter the arrangement of the groups of natural regions: instead of the Pacific regions of North America being comparable with the Atlantic regions of the Old World, there would be a modification of this relatively simple scheme by showing a closer connection between the two sides of the Atlantic Ocean. One would have to take account, not merely of the climatic arrangement expressed as "belts of temperature divided meridionally by areas of different rainfall" (1913), but also of the results of the greatest developments in the Earth's history, for example, in the case of North America and Eurasia, a structural symmetry about the Atlantic depression.

Yet even with the inclusion of the element of structure, the natural resources and environment of man are inadequately surveyed. If coal deposits have hitherto been the chief source of mechanical power and a predominating factor in the determination of industrial areas, they are now being supplemented in an increasing degree by water-power, and although the distribution of water-power is in certain areas due to the elements of structure and climate, as in a mountain region with a considerable rainfall, in other areas it is due to the effects of glaciation, as in the relatively low districts of New England and Eastern Canada. The matter of glaciation, therefore, introduces a new element, and this has also other effects such as a modification of soil conditions which may profoundly affect agricultural activities.

Again, the accessibility of areas is a factor of great importance: in some cases it may determine or prevent the development of regions and may be of greater importance in regard to human geography than any other factor. Moreover, it is so complex and subtle a matter that it cannot be simply expressed, like structure or glaciation, in map form, nor can it be analyzed into a few simple elements in the way that climate has been analyzed into such elements as rainfall and temperature. Accessibility is to be estimated rather by its effects, and can only be appreciated when we consider the human conditions themselves. In other words, this important aspect of man's environment cannot be isolated: we must look beyond the natural or physical conditions even if we wish only to discover and express those conditions.

Indeed even climate can best be appreciated by considering its effects rather than its elements; no attempt hitherto made to express climate by a simple combination of isotherms and isohyets can be considered satisfactory. Annual isotherms are of little value; those showing the average temperature of particular seasons are better, but the seasons must be selected in relation to some particular problem, and maps dealing with one or two seasons cannot be relevant to a discussion of climate as affecting the manifold needs of plant, animal, and human life. For some problems the accumulated temperatures of a period are more useful, but here again those of any one period have only a limited significance. Moreover, when different parts of the world are considered, the same isotherms may have a different value in different regions, and a map which shows them as unvarying may be positively misleading. For example, the amount of heat that is effective in a particular way in some circumstances has not the same effect in others: plant life will develop with a certain temperature in the longer light-period of the summer of higher latitudes which will not develop with the same temperature in the shorter light-period of lower latitudes. Prof. Herbertson's paper on "The Thermal Regions of the Globe" (*Geogr. Journ.*, Nov. 1912) is therefore of value as an inquiry into the best methods of expressing the temperature conditions of regions *per se*, but does not appear to me to be of much service as an aid in determining the natural or geographical regions of the Globe, since it discusses definite schemes which are applied without modification to all parts of the World.

Similarly, rainfall conditions are inadequately expressed by any existing scheme of isohyets: annual ones have some value, seasonal ones have other advantages, but no system is of universal significance. As in the case of temperature, the effect of rainfall varies with other circumstances; an isohyet showing a certain rainfall may indicate the existence of adequate moisture for certain forms of vegetation with a low temperature, but not with a higher temperature; soil conditions also may increase or diminish to a great degree the adequacy of a given rainfall; moreover, methods of conserving soil-moisture over long periods may make the selection of a suitable period even more difficult than in the case of temperature.

The solution of such difficulties seems to lie in considering the effects rather than the elements of climate, for example, to note what vegetation, natural and artificial, can exist in particular areas, and similarly to estimate the combined effect of structure, relief, accessibility, climate, and natural resources by observing the distribution of men, their characteristics and their activities.

Indeed it may be put forward as a general proposition that, in view of the essentially correlative nature of geographical science, the best method of discovering geographical regions is not to bring together on separate maps certain analyzed factors, such as relief, structure, temperature, rainfall, natural vegetation, etc., and to compare these elements, but to take their combined effects as they work themselves out, *i.e.* to take the actual

complex of physical and human conditions, to regard this as a closely interrelated whole, to observe the predominant characteristics of this complex in different parts, and so, by a synthetic rather than an analytic method, to arrive at the determination of regions with common characteristics. After this survey the factors may be analyzed in order to describe the regions, and to explain their peculiarities.

By viewing all the factors of the complex one might obtain geographical regions, which should have a definite place in the future development of geographical science. This development may include the division of the Earth's surface into regions delimited for particular purposes by focussing the attention upon particular phenomena. Indeed a beginning has already been made, and the following examples may be cited. Structure and relief have been studied in order to obtain the "physiographic regions" of the United States by Powell, and recently with more accuracy by Fenneman; the climatic regions of the world have been marked out by Supan and Köppen; and regions of natural vegetation by Schimper and others. A study of agricultural regions has been begun by P. M. Roxby, but other economic studies of this type have yet to be made. Regions based upon ethnological characteristics have been delimited and the method of dividing the earth according to political conditions is only too prevalent.

The idea of *natural* regions in which a number of physical factors have been combined marked a further advance, and this points to the more completely synthetic study of *geographical* regions. Somewhat similar divisions have been made of relatively small areas; I would particularly refer to the study of the United States by Professor Davis in 'The International Geography,' and that of France made by a number of geographers whose work is summarized by Fèvre and Hauser in 'Régions et Pays de France' (Paris, 1909). The natural or physical regions must always have their significance, but the geographical regions will possibly prove of still greater value.

The procedure by which the maps must be obtained will, however, have to be considerably modified: I would suggest the following method. The work should proceed from small districts to large regions, and not begin by dividing up the world as a whole. In each small district the survey should include the relief and structure, obtaining help from such special studies as may have been already made by geologists, like that by Fenneman mentioned above, noting, however, not only land-forms but soil conditions and mineral deposits. It should include also the climate, to some extent utilizing isothermal and isohyetal means of expression, and to some extent also noting the synthetic effect of the climatic factors in making possible particular associations of natural and cultivated plants. It should consider, also, as a factor of independent importance, the natural vegetation covering of the surface, where this has not been transformed by human action; and where it has, the distribution and relative importance of artificial pastures and crops such as wheat, rice, and cotton should be taken into account.

Industries of all kinds should be considered, and, as far as possible, in groups, for the characteristics and inter-relations of "industrial associations" may become a development of economic science just as "plant associations" have become the special subject-matter of a branch of botanical science; this study of industrial associations should include all forms of economic activity, including transport and the means of communication between the individual centres. This promises to be a fruitful field of research for the worker in economic geography, and it may provide maps of "economic regions" which would be of the greatest service to the compiler of geographical regions.

Density of population is an important phenomenon; it is a subtle index of many combined factors both physical and human. In itself it is of great interest, for it is the basis of many economic and social problems (which the geographer should not ignore), and an expression of the productive capacity and therefore the political importance of the area.

The earlier methods of delimitation took into account the physical conditions which affect economic conditions, but in no way, directly or indirectly, did they consider the political, linguistic, racial, or religious affinities of the peoples. These are, in any case, important; they may be so marked as to affect the economic conditions, and they may even determine the utilization or non-utilization of a region, as, for instance, in Northern Australia, where the policy of a "White Australia" practically forbids the economic development of a region capable of great production with the aid of the labour of coloured peoples. In other cases they may reinforce physical factors in determining a differentiation between two areas, and in still more cases they may determine the exact position of a boundary between regions where climatic factors are decisive but offer a gradual transition rather than a sharp line of demarcation. These political, linguistic, racial, and religious factors should therefore be included in the survey, and their inclusion, moreover, may meet the strongest part of the case of those geographers who have refused to make use of the method of natural regions because political divisions, so well known and in many ways important, have hitherto been ignored. Political divisions should in my opinion be given their due weight in the decision as to geographical regions; but that is not to assert that they should be taken as the sole determinative factor so that political provinces, countries, or empires should be our geographical units. It may occasionally happen that a political unit may be a convenient region for study, but the absurdity of making this a general rule is realized when we consider the congeries of different and often discordant units of all kinds, physical, economic, and ethnographical, which are at present bound together in the Austro-Hungarian Monarchy. The method here proposed may perhaps meet the views of the writer of the review of Prof. Herbertson's 'Handbook of Geography' in the *Scottish Geographical Magazine*, who wrote: "The problem as to how a logical division into natural regions can be reconciled with the utilitarian need of

considering political divisions will have to be squarely faced, sooner or later, by geographers."

After a comprehensive survey of a particular district it may appear that its predominant characteristics are certain physical conditions; *e.g.* in a forested mountain area, the relief, climate, and natural vegetation might be well marked and closely inter-related and, from the geographical point of view, more important than a scanty population which has but insignificant influence either upon the physical conditions of that region or upon human life elsewhere. In another district, however, the human factors may be predominant; *e.g.* in a lowland with stores of mineral wealth and facilities for intercourse, a dense population might cover much of the area with their buildings and means of communication, might destroy the natural vegetation, utilize or even modify the surface for their own ends, easily adapt themselves to varying climatic conditions, and form a centre of economic activity and political power determining the development of other regions. In the one case the physical conditions would be specially noted as the characteristic features of the district, and in the other case attention would be focussed mainly upon the economic and political factors.

The general character of the district having been ascertained, the question would arise as to the extent of the area to be included; this would be determined by finding how far in each direction the country continued to bear the same general character, and so the particular method of delimitation would depend upon the particular characteristics of each district. In the first case just considered, that of the forested highland, the relief would probably be the determining factor over a large part of the district; where the mountain slopes sink into the low foothills the characteristics of the region would change and the boundary line would be drawn. In another part of the district it is possible that the forests might change their character or become scanty owing to a lower temperature or a less rainfall; there a vegetation map or a description of the vegetation covering would be utilized to determine the boundary. In the second case, that of the manufacturing and trading district, the density of population might be taken as the criterion and the boundary would coincide with the position of a marked decrease in this density as shown upon the map.

Again, in the case of an agricultural district the production of the chief crops would probably serve as a guide. For example, in the central plains of the United States the transition from the northern to the southern part is very gradual, but nevertheless important. The selection of any particular isotherm or isohyet as a boundary would be quite arbitrary, but the sheets of the United States Census maps which show the production of each of the important crops, such as wheat, maize, and cotton, give a surer basis of division, for lines can be drawn between the districts where wheat, maize, and cotton respectively predominate. These

divisions not only indicate the regions where the particular crops are largely obtained, but they correspond with the complex climatic conditions which favour the various crops, and also with the economic and social conditions which are partly the cause and partly the effect of the particular forms of agriculture; this last point may be illustrated by the well-known connexion between cotton cultivation and the employment of negro labour in the United States, with its many social and political consequences.

When the boundaries of a particular district have been provisionally drawn, the neighbouring districts would be similarly dealt with, their characteristics determined and their limits defined. A reconsideration might be necessary where on one side of a line one criterion, *e.g.* the production of a particular crop, was taken, while on the other side another criterion, *e.g.* a change in the relief or in the density of population, was employed. The position of a boundary would seldom be quite definite, for sudden and definite changes seldom occur, but the reconsideration would increase the value of the delimitation. It would frequently be found that the actual boundary would depend ultimately upon geological factors, such as the relief (*i.e.* height, slope and exposure), the soil conditions, and the existence of mineral deposits, for these determine the precise distribution of phenomena more often than the climatic factors which change very gradually.

To a considerable extent the characteristics of the regions are capable of quantitative expression, and should be so expressed wherever it is possible. For example, the regions having been demarcated, a review of the climatic conditions may be made and the temperatures may be expressed in numerical form, such as annual and seasonal averages, the accumulated temperatures of particular periods, or the mean dates of opening and closing of inland waters or of the appearance of autumn frosts; the particular form would depend upon the peculiar characteristics of each region. Again, production of various kinds should be expressed statistically wherever the data exist, possibly in proportion to the area; for in many districts figures as to agricultural, mining, and manufacturing production are available, and to these may be added others showing the closeness of the network of communications and the amount of commerce; density of population is usually capable of quantitative expression within a relatively small margin of error.

After all the areas in question had been considered, and small uniform districts had been determined with a record of their essential characteristics, these geographical units of the first order would be combined with others adjoining them to obtain larger areas, geographical units of the second order, which though necessarily less uniform would yet have many features in common. In some cases there would be little difficulty in determining whether or not a combination of adjoining areas should be made. In the case of the central plains of the United States, the districts in which the cultivation of wheat and maize respectively predominate

might well be combined, as they are both of an agricultural type, have a similar climate, and support a moderately dense population with many common characteristics; the distinctively cotton-growing districts, however, would probably not be included in the same unit of the second order. As a rule, there would be little hesitation about combining those regions whose precise delimitation presented the greatest difficulty during the first survey, for the slight and gradual transitions which caused that difficulty may indicate broad similarities.

Perhaps the most serious problem in this part of the work will occur where marked differences of structure, such as are found in regions of geological deformation, cause repeated outcrops of certain rocks differing from one another in composition and relief; thus within a limited area, *e.g.* England or Central Germany, agricultural lowland districts alternate with pastoral, wooded or bare uplands, possibly flanked by mineral deposits of great economic importance. In this case the combined area may be noted as having a relatively complex character, and its claim to be treated as a unit will rest not upon uniformity but upon a characteristic combination of certain definite elements.

Another problem will occur where districts, which are essentially geological outliers or inliers, break the uniformity of the larger area in which they are found; here the solution would be to treat the area as though it were uniform, noting, however, the existence and character of the exceptional districts.

After these units of the second order had been determined they would themselves be combined, where this seemed desirable, into geographical units of the third order, still less uniform, yet exhibiting certain important characteristics which would apply at least to a considerable part of their extent and serve to differentiate them from other regions. Thus each of the continents might be treated by a synthetic and not an analytic process. Finally, when all the world had been surveyed, comparisons between the great geographical regions would be instituted, classification of these into groups or types would follow, and a world-arrangement would appear. This world-arrangement of types of regions will not be so simple as that shown in the present maps of natural regions; the arrangement of more or less parallel zones divided meridionally will probably break down, for the present simplicity is, in my opinion, fallacious. The Earth is not such a simple organism, its features are much more complex, and scientific work must never be forced into a fictitious simplicity. A careful consideration of the method underlying the construction of some of the existing maps shows that a part of the grouping of the regions depended primarily on the selection of certain temperature and rainfall conditions as criteria, and where these coincided the regions were declared to be of a similar type; in other words, the world-arrangement was determined in advance by the rather arbitrary selection of these particular criteria, and in this way the apparent simplicity originated.

To facilitate the grouping of the smaller districts into the larger regions the boundaries of the former might be differentiated as the first delimitation proceeded; the boundaries which separate regions exhibiting only slight differences might be marked by dotted lines, those separating regions differing more markedly from one another by broken lines, and those separating regions of strongly contrasted natures by firm lines. Then in forming the larger areas, those smaller ones separated by dotted lines would naturally be put together and the boundaries of the new area would run along the lines more firmly marked. The boundaries of the larger units would of course never cut across the smaller units already determined to be of an essentially uniform character.

This scheme would prevent the selection of undesirable boundaries for the larger regions, which is a marked weakness in parts of the existing maps. For example, the 1913 map has a boundary between two of the major regions running across Canada from the mouth of the Nelson River to the neighbourhood of Winnipeg. This line crosses almost at right angles what one would consider to be the natural lines of demarcation in the country; east and west of it the country is almost exactly the same although the line traverses belts which differ from one another. One can only suggest that a desire to obtain a simple world-arrangement was the origin of the otherwise inexplicable course of this boundary. Again, the 1911 map has a boundary consisting of a straight line running from west to east across the central plains of the United States cutting the Mississippi flood-plain into two approximately equal portions: the southern portion is a part of the "Floridan Province," the northern portion (which differs from it in no essential particular) is a part of a great region which includes also New England and Nova Scotia. Any division of a continent will find critics, for no two geographers will view the facts in precisely the same way; but the method here suggested should make such remarkable divisions impossible, if only by associating a detailed examination of the regions with the drawing of the more important boundaries.

At this stage in the argument a possible objection to the plan here proposed may be met. It may be said that the natural or physical regions (as hitherto determined and distinct from the proposed geographical regions) tend to become economic regions as they are developed by man, so that they serve to indicate the potential if not the actual economic conditions. The answer is that there is no certainty that two regions or two parts of the same region which are alike physically will develop in the same way; indeed, there is every probability that they will not. For example, coalfields are likely to favour in their district some form of industrial activity, but what precise form will appear it is impossible to foretell. Nature makes possible a number of developments, but which one will appear depends upon the incalculable human factors.

The objection may also be raised that the human conditions change, and that to introduce them is to make the divisions of only temporary

relevance. It may be answered that the racial, linguistic, and religious factors change but slowly; that very slow change is also to be predicated of climatic conditions; and that even the configuration of some districts suffers appreciable change within measurable periods, as did Holland in the period immediately preceding the thirteenth century; in other words, it is the rate rather than the existence of change that makes the problem. This is most marked in the case of the purely political factors where almost kaleidoscopic transformations may take place, and yet even this difficulty affords no reason for omitting the political factors. The Earth with all its inhabitants forms one great "macro-organism," as Prof. Herbertson called it, which develops and evolves; consequently the science which aims at describing and explaining its characteristics must take account of the changes, and cannot, indeed should not, attempt to regard the conditions as immutable. On the contrary, one of the objects of geographical science should be to observe this evolution—in what areas, in what manner, under what circumstances it occurs. If the geographical regions take into account the factors which undergo relatively rapid change they will, of course, have to be reconsidered and reconstituted at intervals, but a comparison of the results will afford most valuable data for the study of the evolution of the macro-organism. That changes are inherent in this method of determining geographical regions may indeed add to its value, rather than present insuperable difficulty. And, after all, a reconsideration of regions determined in any way must be periodically undertaken as our knowledge of facts and our powers of analysis and interpretation increase.

To recapitulate the chief suggestions:—

(1) The present delimitation of natural regions is based upon physical conditions; geographical regions should also be delimited, taking into account the human equally with the physical factors.

(2) The present method depends upon certain analyzed elements such as isotherms and isohyets of various kinds; the geographical units should be obtained as far as possible by considering the synthetic effects of these and other elements.

(3) The geographical units should be determined as areas having common predominant characteristics; these and the less noticeable features should be recorded accurately and as far as possible quantitatively.

(4) The method hitherto adopted analyzes the world as a whole into large divisions; the proposed method is to proceed synthetically by building up the larger regions from smaller areas already delimited and characterized.

This scheme will necessitate a great deal more work, but it affords opportunity for combined and co-ordinated effort. If different workers examine areas for the study of which they have special facilities, make the divisions, and indicate the characteristics as accurately as possible, these divisions can be co-ordinated; ultimately their classification and the great world-arrangement can be proceeded with upon an assured basis. The

present method of each worker surveying the whole world does not permit of such accurate work, nor is it capable of adequate criticism and co-operation.

The scheme is now put forward for the sake of obtaining discussion on the main ideas, and as a suggestion to other workers who may be able to undertake the study of particular regions.

After Dr. Unstead read the paper a discussion followed.

Dr. J. W. EVANS: We are all very much indebted to Dr. Unstead for the interesting and suggestive way with which he has dealt with a difficult problem. I may say at once that I am on the whole in agreement with the point of view he has taken. The question of the classification and delimitation of different areas depends, of course, to a large extent on the purposes for which the classification is to be employed. It seems to me that the great object of geography is to place on record, especially for future generations, the distribution of phenomena on the face of the Earth at the present time, and the areas into which the Earth is divided for this purpose must be determined according to the facts which are to be recorded. There must be zoological regions in order to record the present distribution of animal life; and these will in many cases be different for different classes of animals. In the same manner to express geological facts the areas will vary according to the point of view. You may, with Dr. Unstead, place great stress on structure, and classify together those regions which have the same structure, even though the surface forms and lithological characters are different, or you may take either of these last as your basis of delimitation.

Such a multiplicity of classifications seems inevitable, particularly if the divisions are of considerable size; but I agree with Dr. Unstead that to obtain a useful classification and delimitation of geographical districts for general purposes, and especially in relation to human development, you must begin with comparatively small areas. A particular spot may be taken as a starting-point, and the conditions that affect the human race in that locality, such as the temperature, the rainfall, elevation, surface forms, and other less obvious factors carefully considered. If, then, you move on in any direction you will find these conditions gradually changing, and where these changes are sufficiently numerous and important to affect materially human existence you will be justified in saying you have come into a different region. The areas arrived at in this way will vary greatly in size and form.

I agree, too, with Dr. Unstead that you must judge largely by results. A particular influence may be unimportant in one area, and of vast importance in another. The lower portions of the basins of the Amazon, the Congo, and the Ganges are very similar in climate and other respects, but vary greatly in the condition of their human population. In the African area there are germs that make malarial diseases of the very greatest seriousness, especially to Europeans, and the result is that for a long time it was shut off from the outside world. In the Amazon region there are more healthy conditions, but its remoteness and the character and scantiness of its population has retarded its development. On the other hand, the proximity of the north of India to the ancient civilizations has caused its early development and made it one of the most populous regions in the world. The chief point with which I am inclined to differ from Dr. Unstead is that I doubt very much whether you will gain anything by uniting the minor divisions to form others of larger size. You

will rarely find two regions showing very great similarity, and when you do they will not as a rule be contiguous.

Contrary to the opinion expressed by Dr. Unstead, I believe that from the human standpoint the political conditions and divisions are of the very greatest importance. According to the political system that exists in a particular country its development is influenced perhaps more than by any other single factor. It is impossible to exaggerate the effect that any changes in political boundaries and institutions resulting from the present war may have on the evolution of the human race.

Prof. LYDE: I have had the opportunity of reading the paper, and have covered the margins of my copy with all sorts of queries and cross references, but have not time to deal with them. I would like to take up one point, just the real aim of this synthetic method of teaching, and treat it from the historic point of view as far as my own experience goes. Dr. Unstead's paper interests me most on account of the change I have been noticing in him for some time now—the change from an ultra-analyst to this statesmanlike synthesist. It is due to his persistent industry and untiring energy. I think it is true of all men, especially of students and statesmen, that such an attitude of mind, tireless industry, honesty, and courage to confess a change of view is very honourable; and I would like to express my admiration for this trait in Dr. Unstead's work. When I come to criticize the paper from this synthetic point of view, I represent one of the few left in this country now of a little band who have always taught on the synthetic line. We had at first a great deal of friendly ridicule, but it seems to be passing away now, and Saul is joining the Prophets. I believe we hit upon an indigenous British method, and we knew too little about German and American methods to be lured away from that as greater geographers were. As I was the Chief Scribe, I would like to mention to you some actual dates. Our first publication in 1895 stated definitely we had discarded the old stereotyped way of dealing with the Earth, and were trying to replace it with one in which we could synthesize phenomena in groups of kindred character. Next year we repeated a similar thing, but tried to fling our net wider. Then, in 1898, I talked to Dr. Herbertson, and said if only he would help us, we might make some progress. I suggested a book on 'Man and his Work,' and you know the result. That was his first concrete step to the position he afterwards developed in the 1905 article. But that unfortunately took him farther away from us and our aim. Then, in 1909, in another little publication I discussed Dr. Herbertson's "major natural regions," and rejected them on the ground that their unity was only physiographic, while their human note was often contradictory. But our aim, while relating each region to the Earth, was still more to relate the people to the place. We appealed for a synthetic method of work; that geography must be "outlook," not "inlook"—a synthesis, not an analysis, and that its method should be exactly what Dr. Unstead asks us to do now, our exact words being "make the regional synthesis by moving gradually out from a chosen base." Of course, therefore, we entirely sympathize with and support Dr. Unstead; and I would even venture to suggest that the experience of twenty years which we have had in actually trying to teach synthetically, may throw light on the comprehensive view, the moving outwards from the chosen base, and the precise end to be sought. We had three lines of approach—a world approach, an historical approach, and an economic approach. Now in this paper, for instance, Dr. Unstead asks that we should pay special attention to such things as the relation of an area to the Atlantic and its accessibility. To us that was part of our essential

background. We began with a world-picture. We traced, first of all, the great world water-partings, and therefore from the first, whatever afterwards was done, everybody realized the alternative of the wide ocean with the narrow hinterland, and the narrow ocean with the wide hinterland ; every one had at the back of his mind, *e.g.*, the conviction of a certain picture of a typical Atlantic hinterland. Of course we associated the fishing industry with a coast good for fishing, and the control also of that. The same with our historical geography. We followed old Rome to Dalmatia. She went there to stop the pirates. We were quite prepared to believe that such a coast must be a pirate coast; quite prepared to believe that the pirates were under a queen ; so far from being surprised at it, we expected it. We always recognized such an organization with the fishing coast and industry. That is our answer to Dr. Unstead's appeal that we should regard these things : pay special attention to man's distribution, to his characteristics and activities. Of course we pay attention to man : he was the only invariable object of our synthesis. So far did we ignore anything we could not relate by cause or effect with man, that we never studied features or phenomena for their own sake. When Dr. Unstead goes on to say that "in none of these cases did they consider the political, linguistic, racial, or religious affinities of the people," nothing could be less true of the work we were doing. We were always trying to do that, and we did it exactly in the way he asks us to do it. We worked outwards synthetically from a small area, and we pressed the predominant note ; or, as we called it, the differentiating factor. To give a couple of instances. Nobody could begin the applied geography of Asia without having at the back of his or her mind a sub-conscious picture of the Human Note over this huge great continent ; how in the region flanking the cold desert the wavy-haired man was dominating the lank-haired ; in that flanking the hot desert the lank-haired was dominating the wavy-haired ; in the tropical monsoon the wavy-haired was dominating the wavy-haired ; and in the temperate monsoon the lank-haired was dominating the lank-haired. That was part of the mental equipment with which they went to the area. It was essential. We did the historical geography of Germany in the same way. Our chosen base, of course, was Hohenzollern, with its streams flowing to both Rhine and Danube. We followed the Hohenzollern occupation of the Nurnberg market which linked the Rhine and Danube trade. We argued, with Frederick of Hohenzollern, that, if the link between these two rivers was so profitable, it was worth while buying the Brandenburg link between the other two great rivers, Elbe and Oder. We noted the typical steppe tyranny of Brandenburg, associated with the military and ecclesiastical arrogance of the Teutonic Order in East Prussia. We compared that Order with the rival Templars and Hospitallers, emphasizing the fact that, with equal military and priestly arrogance, it added the arrogance of a narrow tribal base. It was, therefore, poorer than its cosmopolitan rivals, and courted the towns, and so survived when the Templars collapsed. And so we moved on till we saw Albert of Hohenzollern made the Grand Master by clever intrigue in the middle of the Reformation ferment—to declare himself a Protestant, secularize his territories, and make them an Hereditary Duchy to the House of Hohenzollern.

These were the sort of things that were part of our mental equipment, and you could not go to the area without having them sub-consciously in mind. We did exactly the same thing with our economic geography ; but the only thing I have time to suggest is that I think there was a little inconsistency in Dr. Unstead's paper. At the beginning of it he presses that the other factors were independent and of equal importance with the relief and climate. Then later on

he presses the importance of emphasizing the predominant factor. North-Eastern America may be like North-Western Europe in, as he says, "most particulars," if you mean numerically most; but the particulars are not of equal value—the differentiating factors say that it is not like North-Western Europe, *i.e.* an area north of 50° and east of the Atlantic and an area south of 50° on the other side. In any case history does not repeat itself, and geography does not either. Just as he objected to a "fictitious simplicity," so we object to a "fictitious unity"; and when you have synthesized your "major natural regions," or—as I would prefer—"*minor* natural regions," and added your human note, what have you got? You have your geographical region, but it has no association whatever with the daily life of the world; it has no unified statistical record, no accepted common interest. This little band of teachers which I have been trying to speak for, would have accepted most cordially every single process Dr. Unstead suggests, and thanked him most warmly for them, but our end was slightly different. Our experience would suggest that his end is very difficult of attainment in the present state of Society—and nationality has not been weakened by this war—and that he cannot do the thing in a way that would be worth doing. It is not worth while doing it because there are no large geographical regions truly comparable, so that you could classify them together. On the contrary, his method does give a convincing picture of the political unit.

We would, therefore, cordially welcome Dr. Unstead—with his wide knowledge, his untiring industry, his courage, and his ingenuity—as a convert to our general geographic creed, but we would hope that he would become a convert also to our particular aim—to picture the political unit, a picture which is both attainable and really valuable, rather than try to picture what seems scarcely attainable and has little value in practical life.

Mr. ROXBY: I do not feel that my mind is sufficiently made up on this subject to enable me to make anything like a reasoned contribution to the discussion, but I want to raise one or two points. I read Dr. Unstead's paper with great interest, and I think it is very suggestive. I hope that eventually Dr. Unstead, with the help of a good many other people, may be able to build up a map on the lines which he suggests. I do not feel, however, that this method ought to supersede the one which Dr. Herbertson advocated, and I do not suppose that Dr. Unstead wishes to suggest that it should. In his paper Dr. Unstead asks the question whether the term "natural region is intended to relate only to natural, in the sense of physical conditions, or to indicate the regions which are marked out by natural, as distinct from artificial boundaries." I have always thought of a natural region as denoting physical unity, and I think of regions of different physical patterns. That being so, I should regard the idea of geographical position, in the sense of relative accessibility, as extraneous to the root idea of a natural region. Of course that must be taken into account when you come to applied geography, and a very interesting study results from comparing two regions similar in physical conditions, but differently placed with regard to the world's markets. We can then begin to distinguish the relative importance of different factors. So, also, with human conditions. These, too, I regard as extraneous to the root idea of a natural region, but the same principle holds good. If you have a number of regions physically alike, but under different human conditions, then it is very interesting to see whether they develop along similar lines. If they do not, to what differences in human conditions is it due? For example, take Java as illustrating a certain very important type of natural region. Under certain conditions of Government,

Administration, etc., it has been brought to a very high state of economic development. There are a good many regions with somewhat similar physical conditions, and it will be interesting to see how far they approximate to the Javanese type of economic development. It seems to me that we can to some extent study the effects of different tropical administrations by comparing Dutch Java with the development of other similar islands under the control of a different Power.

So from this point of view it seems to me that we gain by keeping the idea of a natural region to one which is determined by physical type and physical type alone. I do not say that the other method of classification is not also good. It is another question whether Dr. Herbertson's classification of "Natural Regions" is the best on the assumption I have made as to the criteria to be adopted. I think myself that it is a very suggestive classification, and I should like to take this opportunity of saying how useful I have found it in university work. Dr. Unstead has pointed out some weak points in it, and no doubt many modifications could be made. But the main point which I wished to raise was as to the meaning of the term "natural region.'

Mr. B. C. WALLIS: I should like to turn the discussion a little to what I take to be the main purport of Dr. Unstead's paper, the antithesis between the synthetic and analytic methods. Prof. Lyde's remarks show quite clearly how that antithesis comes about in Dr. Unstead's mind. Prof. Lyde said that Dr. Unstead has arrived at his present synthetic state of mind after having been an ultra-analyst, and I would suggest that that idea is an important one from the point of view of geographical science. Dr. Unstead's suggestion of a synthetic method based upon small areas which are measured or classified or tabulated according to their dominant or differentiating characteristics by various individuals implies behind it a great deal of analytical work which must precede any synthesis which is made; and the illustration which Prof. Lyde gave points to a weakness in the suggestion of this paper. The paper itself sets up, I think, an attempt at a scientific ideal, and, if I may say so, Prof. Lyde's opposition sets up a different ideal—an ideal of personality. Scientific ideal is impersonal. The "Prof. Lyde ideal," is personal. I am sure you will all agree that Prof. Lyde can teach his pupils, and write his books, and discuss lank and woolly-haired people; and other geographers would treat those matters as supremely of no importance. If that is so, from the scientific point of view probably both of them are wrong. From the scientific standpoint it becomes a matter of importance whether the suggested method of Dr. Unstead or the older analysis is more important. It has been a weakness in geographical papers that the writer of the paper does not always provide a clear-cut idea as to the sources on which he bases his results. That is illustrated in Dr. Unstead's paper by his criticism of the four maps. He does not always seem to know how the author of the map arrived at his results. It is therefore quite possible that Dr. Unstead is going too far in attributing to those maps a greater degree of importance than they appear to bear. It is undoubtedly true that they are suggestive, and, as results of the analytic method, are probably quite useful. The difficulty is that a similar method has not been applied to other departments of geography. There has been no attempt to cover other topics in the same way. You have your so-called "natural regions" where the emphasis is upon the physical elements of Nature, but you have not had the "human regions" analyzed in quite the same way. If that had been done it would then be quite possible to synthesize the world.

Mr. E. J. ORFORD: There are several points which have occurred to me. In the first place most people are agreed, I think, that it is necessary we should

divide the world up into regions; and, secondly, that the present system, based on the maps which Dr. Unstead has shown us, is not the ideal classification. From my point of view the great object in dividing the world up is in order to be able to teach the various parts more easily. If we talk in school or at lectures about the Amazon Basin and discuss that very fully, and then go to the Congo Basin, there is a very great saving of time in dealing with this second region. Might I say with regard to "natural regions" on Dr. Herbertson's map that two of those "natural regions" are compared in the current number of the *Geographical Journal?* One is the Titicaca and the other the Sang-po region. The author points out that these two regions from the point of view of "natural regions" are exactly similar, and yet while one is a practically uncivilized country, the other is almost civilized, its civilized condition being due to the accessibility that Dr. Unstead spoke of in his paper. With regard to the elements that we might consider in building up these regions I would like to suggest such combinations as Lancashire, Cheshire, and Wales. In Lancashire we have coal and a manufacturing country: in Cheshire an agricultural country interdependent with Lancashire. Connected with those there is a Welsh highland. In Belgium we have a manufacturing region, interdependent with that an agricultural region, and again a highland region. In Germany, too, we have the industrial region; the coal region; the agricultural portion of the country; and then the Rhine highlands. There must be some common underlying reason for these resemblances, and I think that a region which shows some such combination as do these portions of three separate countries might form one, at any rate, of the geographical regions to which inquiry might be directed.

Dr. UNSTEAD: I may be able to clear up one or two matters, and I will take them in the order in which they were presented to us. Dr. Evans suggested at the end of his contribution to the discussion that he doubted whether it would be found that large areas could be dealt with as units when the small areas had been put together, that is, whether one would get any satisfactory large regions which could be described in terms that would apply to a good deal of their area; secondly, whether any definite world arrangement of the regions would come out. I think those are two very important questions for geographical science to determine, and I should be glad if the world could be divided up in the method I suggested if only to see whether the world is, or is not, capable of being divided up into large areas, and also whether there is any great world arrangement of regions. The present method of dividing natural regions assumes both questions, and whether those assumptions are well based might quite well be investigated. I should like to thank Prof. Lyde for his very kind remarks, though I am not sure that at all points I recognize his account of my scientific evolution. Moreover, I think he suggested that my present position is that the human element must be taken as predominant everywhere, but this is not quite my view. I think the human element should come very largely to the front, and in certain regions should be considered as predominant, but not in other parts, for in certain cases the physical conditions are predominant and would determine the delimitation of the region. I think I must make it clear that when I said in the paper that the older divisions did not consider human affairs, I was only referring to this matter of the division of the world into regions. I am far from wishing to minimize the importance of the work of Prof. Lyde and others, but so far as I know his school has not attempted to make a map of the world. May I make clear to Mr. Roxby that I do not wish to supersede the natural regions of Prof. Herbertson or others? I suggest that in addition to those there should be this new method of determining and delimiting regions. I think with him that

the natural regions as well as these broader geographical regions are required. In regard to the analysis of causes, he suggested you might study maps showing the physical regions to see how far accessibility or other factors have affected the differences between their developments. I quite agree, and I believe maps made on the plan I suggest would help in that problem; these maps showing the actual conditions might be compared with those showing the physical environments. I am not sure I agree with Mr. Wallis when he says that the small regions must be dealt with by analytic examination. They must be dealt with by means of very careful, almost minute work, but not necessarily and exclusively analysis. It is not necessary in each region to analyze all the temperature conditions by themselves, and all the rainfall conditions by themselves, but rather to find the combined working out of these things. Mr. Orford has mentioned that he experienced a difficulty in using the present methods of natural regions in teaching. It is because I had experienced the same difficulty that I was led to this other method. If in elementary teaching one wishes to deal with a certain part of the world, say, South America, and to teach what the region is like, one might first teach the home country and then use a map such as one of these, which would show that the extreme south-west of South America comes into the same group; if one then inferred that that region is in most respects like our own region, I think one would give the pupils more wrong ideas than right. So if the method of Prof. Herbertson or others of dividing up the world into regions is to be applied in teaching, we must not have, I think, purely physical regions, but more completely geographical regions. I think Mr. Roxby may see from this example more clearly what I aim at. I am getting these broader divisions only as one means of geographical expression, and I hope they may be of service in teaching. I am pleading, indeed, for an addition to the present methods, and believe that only by combined, careful, and very detailed work can results of any value be obtained.

The PRESIDENT: As far as I have been able to follow the valuable discussion between experts in geographical teaching we have just listened to, I think the main point Dr. Unstead has been putting before us is that he wishes to broaden the grounds on which we classify Regions—to introduce the human element to a greater extent. I have no doubt the course he recommends is one which will lead both teachers and students to interesting investigations and very useful results. It seems to me there are many ways open of classification; one man will follow one method and one another, and they may be all found more or less suggestive and useful. The geographer is in the position of a man who has a store of pieces of marble and can arrange his mosaic in many different ways, each of which will produce a valuable result. It may be arguable whether Dr. Unstead's way is the best, or whether it is only one of many good ways. Of one thing I feel sure, that whenever he and Prof. Lyde are both here we shall have stimulating discussions and interested audiences. It only remains for me now to offer your thanks to Dr. Unstead for his paper, and to express our gratitude to the other gentlemen who have contributed to this discussion in so able a manner.

Mr. H. O. BECKIT sends the following communication: I wish first to say that I entertain a good deal of sympathy for some of Dr. Unstead's suggestions, notably for his preference for beginning work at the large-scale end, dealing with simple units of restricted extent, and proceeding cautiously to the larger complexes later. On the other hand, I believe that many among his audience

will have wished that the author of the paper had chosen to submit some specimens of his proposed divisions worked out in as much detail as may be. There is in my mind a lingering suspicion that the evident complexity of the methods suggested may turn out to be so great as to reduce their utility even to vanishing point. I confess that I do not fully appreciate—perhaps have not quite understood—his assignment of the several tasks of geographical analysis and synthesis. The former process is, of course, properly a means and not an end, but I think he undervalues the part it ought to play. I wish also that the paper had taken account of other attempts at world-division, some independent of, others derived from, Prof. Herbertson's well-known work, and may perhaps instance the German attempt of Dr. Banse, that to some extent follows lines of which Dr. Unstead evidently approves. As regards the usefulness of a division into natural regions, I imagine that one is involved, on the one hand, with the question whether the geographer's aim is the estimation of actual and often temporary, or of ultimate and permanent values, and, on the other, with the not less important practical problem how far cross-classifications, with their inevitable want of uniformity of criterion, both qualificative and quantitative, are really truthful and satisfying. In Prof. Herbertson's division, as Dr. Unstead suggests, the climatic factor was allowed predominant weight; I do not believe I am alone in setting a high value on the simplicity—I would add the significance—of the resulting classification. The difficulty of dealing, in any similar scheme, with the transition phenomena of borderlands appears to me to be inherent in all geographical treatment that has to cover the whole world.

THE UNEXPLORED AREAS OF CONTINENTAL CANADA.

Charles Camsell, Geological Survey of Canada.

SIGNS were not wanting previous to the outbreak of the great war that a new interest was arising in the exploration and development of the northern parts of the Dominion of Canada. This was perhaps most evident among men of the mining industry, whose interest has always been aroused by the stories told by returning explorers and travellers of the evidences of mineral wealth that occur here and there throughout that vast northern region. The building of several lines of railway through country that only a few years ago was absolutely unexplored has no doubt been the chief cause of this renewed interest. The new National Transcontinental and Grand Trunk Pacific Railway, the Hudson Bay Railway, and other railways into the Peace and Athabaska countries not only open up a great deal of new and unprospected country but make it easy for the prospector and explorer to get into the wider fields that lie to the north of these lines. The Hudson Bay Railway, for example, with its terminus at Port Nelson on Hudson Bay, traverses about 400 miles of country which is only now being prospected, besides making on its completion virtually the whole shore-line of Hudson Bay easily accessible to the energetic prospector for

a season's work. The railways also from Edmonton to Fort McMurray and Peace River make it possible for explorations to be carried on in various parts of the basin of Mackenzie River without the explorer being compelled to winter in that region.

In anticipation of a renewed interest in exploration that will probably follow a return to normal conditions at the close of the war it seems advisable at this time to take stock of our geographical knowledge and so arrive at some conclusion as to what yet remains to be done within the confines of the Dominion.

Almost any one unfamiliar with Northern Canada, looking at the map of that region, will immediately come to the conclusion that there is little territory left to explore except on the Arctic islands; and, indeed, this is a very common impression held even by Canadians. This is because our maps have no large areas on which some geographical features are not shown, nor is the word "unexplored" written across the face as formerly. If, however, we make a more critical examination of the sources of the information that is shown on the map, and inquire from the mapmakers where they get their information on a certain area, they would probably refer us to some older maps the data for which were of the vaguest kind, drawn perhaps from hearsay, or from Indian sketches, or other unreliable sources. The mapping even of some of our early explorers is so crude that no dependence can be placed upon it. Some of them unfortunately had neither the mental training to observe and record, nor were they equipped with the means of making reasonably accurate sketches. The result is that their representations of the physical features are inaccurate and misleading and must necessarily be done over again.

It is unfortunate that any part of the map of Canada should contain information of that kind; but in many cases it was put on without sufficient knowledge of the source from which it was derived, and at one time perhaps with the idea that such information was better than none. Only those who have attempted to use an inaccurate sketch in working their way through new territory can appreciate how misleading and often dangerous such a sketch can be. It is often far better to be without any false aid of that kind and to depend entirely on your own judgment and experience to find your way through a piece of unexplored country. Sketches drawn by Indians must be used with a great deal of caution and with some knowledge of Indian character and of the individual himself.

The exploration of Northern Canada is intimately associated with the fur trade, particularly with the operations of the Hudson's Bay Company and to a less extent the North-West Company. During the eighteenth and early part of the nineteenth centuries practically all the explorations made were with the object of extending the field of operations of the fur traders and to get into touch with new tribes of Indians with whom the trade could be carried on. Such were the explorations of Mackenzie in the

north-western part of Canada, of Hearne on the west side of Hudson Bay, and of Clouston and McLean in the Labrador Peninsula. The fur traders were followed, and occasionally preceded, by the missionaries, who also did much to increase our knowledge of the geography of those regions.

Scientific exploration, however, may be said to have been begun in the northern interior of Canada when Sir John Franklin made his first expedition to the Arctic coast in 1819. His second journey, and the later expeditions of Back, Richardson, Rae, Dease, and Simpson, greatly extended our knowledge of the geography, and added much exact information on the natural history of the northern central part of the continent.

During the latter part of the last century the burden of exploratory work, which had up to that time been borne entirely by the fur-trading companies, the missionaries, and by explorers financed outside of Canada, was undertaken by the Government of Canada and carried on mainly by officers of the Geological Survey. The most important of these explorations were those of R. Bell, Dawson, McConnell, Tyrrell, Dowling, McInnes, Ogilvie, J. M. Bell, Keele, and Camsell in the western part of the Dominion, and of Low in the Labrador Peninsula. In fact, a very great part of the geographical map of Canada, as it is to-day, is the work of the Geological Survey; and there is no doubt that the surveys of its officers have added more to our knowledge of the natural resources of the Dominion than the work of any other group of explorers.

In 1890 Dr. George Dawson made an estimate of the area of unexplored territory in Canada exclusive of the Arctic islands. His results were obtained in this way. For all lines along which reasonably satisfactory exploration had been made he gave a width of 50 miles; that is to say, he assumed that the explorer learned something of the country 25 miles on either side of his route. The areas between these lines were measured and in this way he calculated that there were about 1,000,000 square miles of unexplored territory in Canada. About 600,000 of this lay in Western Canada, the rest being in what are now the provinces of Ontario and Quebec. No area of less than 7500 square miles was included.

Recently I had occasion to revise this estimate; but believing that the 50-mile strip was too wide, I took a strip 15 miles on either side of the explorer's route and reduced the explored lines to a width of 30 miles, which, I think, is ample. The result is that I find in Western Canada areas aggregating 642,000 square miles in extent which must still be considered as unexplored, and in Northern Quebec about 259,000 square miles more, making an aggregate of 901,000 square miles on the mainland of Canada. This does not include areas under 4000 square miles in extent.

The areas of the various unexplored blocks are summarized in the following table, the figures of which are given in round numbers :—

UNEXPLORED AREAS IN NORTHERN CANADA.

	Sq. miles.
1. North of Porcupine River, Yukon	8,000
2. West of Porcupine River, Yukon	4,000
3. West of Peel River, Yukon	14,000
4. East of Peel River, Yukon and N.W.T.	30,000
5. West of Dease and Francis Rivers, Yukon and B.C. ...	8,000
6. North of Liard River, Yukon and N.W.T.	40,000
7. West of Fort Nelson River, B.C.	28,000
8. North of Peace River, B.C., Alberta and N.W.T.	40,000
9. North-west of Great Bear Lake, N.W.T.	61,000
10. North-east of Great Bear Lake, N.W.T.	11,000
11. South of Great Bear Lake, N.W.T.	40,000
12. West of Coppermine River, N.W.T.	14,000
13. North-east of Coppermine River, N.W.T.	10,000
14. North of Great Slave Lake and Backs River, N.W.T. ...	61,000
15. South and east of Backs River, N.W.T.	72,000
16. East of Slave River, Alberta and N.W.T.	4,000
17. North of Athabaska Lake, N.W.T.	47,000
18. East of Dubawnt River, N.W.T.	30,000
19. South of Athabaska Lake, Sask.	12,000
20. East of Cree River, Sask.	5,000
21. West of Reindeer Lake, Sask.	4,000
22. East of Reindeer Lake and Kazan River, Man. and N.W.T.	73,000
23. South-east of Churchill River, Man.	4,000
24. South-east of York Factory, Man. and Ont.	6,000
25. North-east of Island Lake, Ontario	8,000
26. South of Winisk River, Ontario	8,000
27. West of Ungava Bay, Quebec	75,000
28. North of Eastmain River, Quebec	65,000
29. East and south of Kaniapiskaw River, Quebec	54,000
30. East of George River, Quebec	32,000
31. South of Hamilton River, Quebec	32,000
Total	900,000

A comparison of Dawson's figures with my own, in so far as that can be made, shows that since his results were published twenty-six years ago, the provinces of Ontario and Quebec have reduced their unexplored areas more than any other part of Canada. This is due mainly to the surveys of Low in the Labrador Peninsula and of McInnes and others in Northern Ontario. In Northern British Columbia and Yukon a great stimulus to exploration was given by the discovery of the rich goldfields of the Klondike, and much new country was gone over in the search for other goldfields. While nothing of that nature occurred in the region between the mountains and Hudson Bay, important explorations have, however, been successfully carried out by J. B. and J. W. Tyrrell, Hanbury, J. M. Bell, and the writer.

The total area of Canada is reckoned at 3,729,665 square miles, of which 520,800 square miles is embraced in the islands of the Arctic Ocean.

There are left, therefore, 3,208,865 square miles as the area of that part of Canada on the continent of North America, which is that part to which this paper refers. A total area of 901,000 square miles of the mainland, according to our calculation, is still unexplored, or almost 28 per cent.

It would, of course, be incorrect to say that no traveller had ever entered any of the blocks which go to make up the total unexplored area. That is only true of very few of them. But even though certain of the blocks have been entered by travellers they must to the world at large still be considered as unexplored; because in some instances no reasonably accurate surveys have been made and in others no records left of the geography, life, or general character of the region traversed. In the area north-west of Great Bear Lake, for example, Petitot and Macfarlane made a number of expeditions; Pike, Hanbury, and others have been into the area north of Great Slave Lake; Hearne crossed the blocks east and west of Kazan River and that north of Athabaska Lake; while associated with the Labrador Peninsula are the names of a great many traders, missionaries, and certain others whose chief object was perhaps their own amusement. These are only a few of the names that come to mind of men whose work was excellent in many respects, but left much to be desired from the point of view of scientific exploration.

The information obtained by the various travellers along the routes traversed by them is sufficient to give us some idea of what the general character of the country might be in the areas between these routes. From these sources we are able to infer that there are three distinct types of country in the unexplored regions. These are exemplified in the southern portion of the Dominion and may be seen on a journey from Montreal to the Pacific on any of the transcontinental railways.

The first and most important of these types is the Laurentian Plateau region, which on our transcontinental railways extends along the north shore of Lake Superior and as far as Winnipeg. Two-thirds of the unexplored regions belong to this type of topography; for the Laurentian plateau is supposed to cover the whole of the Labrador Peninsula and extends west of Hudson Bay as far as a line drawn through Athabaska, Great Slave, and Great Bear Lakes to the Arctic coast. The surface of this region is rough and rocky, and covered with little or no soil; the vertical relief is generally only 200 or 300 feet, though in North-eastern Quebec it reaches some thousands. It is wooded, except to the north-west of Hudson Bay in the regions known as the Barren Grounds, and in the northern part of the Labrador Peninsula. Its irregular pitted surface is covered with innumerable lakes, which make it possible to travel in almost any direction by canoe; but its streams are interrupted by numerous rapids and falls, making portages necessary.

The second type is that of the Great Plains of Central North America. Where the Canadian Pacific Railway crosses them they are about 1000 miles wide, extending from Winnipeg to the foothills of the mountains.

Northward down the valley of the Mackenzie, however, the Great Plains region gradually narrows down between the Laurentian Plateau and the mountains until in lat. 65° N. it is only about 220 miles wide. This region is heavily wooded, has a well-developed drainage, and a surface which is broken only by a few isolated ranges of low hills. About 110,000 square miles of the unexplored regions lying on either side of Mackenzie River between Great Slave Lake and the Arctic are of this type. This includes areas in the table numbered 8 and 11 and parts of 4 and 9.

The third type is that of the Cordillera, and the unexplored parts cover some 130,000 square miles of the Rocky, Mackenzie, and Richardson Mountains. This includes the blocks lying west of the Fort Nelson, Liard, and Mackenzie Rivers, which are numbered in the table as 1, 2, 3, 5, 6, 7, and the greater part of 4.

It is fairly well known from the character of the surface and the geographical position that the majority of the unexplored blocks are quite unfit for agricultural purposes. This is very largely the case with those which lie within the Laurentian Plateau and the Cordilleran Province. Those blocks, however, included within the area of the Great Plains are better suited for agriculture as regards soil as well as climate, and especially that block lying north of Peace River and west of Great Slave Lake. In this area, along the valleys of rivers, and wherever the drainage is good, it is expected that the conditions will be more or less favourable for agriculture. Certainly the country immediately to the south of that block, where the physical features are very similar, offers excellent opportunities to the farmer and rancher who in considerable numbers are now taking advantage of them. The Peace River and Athabaska River regions contain perhaps the largest area of unoccupied agricultural lands in Canada, and the northern part of the Great Plains is the direction more than any other in which Canadian expansion in agricultural pursuits is bound to take place.

The other unexplored areas are more likely to be of value for their mineral resources than for anything else, and prospectors are now beginning to work along the southern fringes of them. If we superpose these unexplored areas on the geological map of Canada we shall find that the greater part of them lie in what is coloured as pre-Cambrian, or in geological formations similar to those in which, under certain conditions, the rich deposits of copper, nickel, iron, silver and gold of Northern Ontario occur. Signs are not wanting that deposits of similar minerals of perhaps equal richness occur in various parts of the unexplored north—such, for example, as the copper deposits of the Coppermine River and the Arctic coast, and the iron ore deposits on the shores of Hudson Bay, of Great Slave and Great Bear Lakes.

In the northern parts of the Great Plains also there are numerous evidences of mineral wealth, the most important being that of oil, springs of which have been noted on the shores of Great Slave Lake and at

several points in the valley of the Mackenzie and on Peel River. It is estimated that the rocks which are the source of this oil, namely, the Devonian strata, are the surface rocks of about 150,000 square miles of the lower Mackenzie Basin, while in the southern part they extend under a larger area of younger rocks, so that their total area covers not less than 300,000 square miles. The future as regards oil, therefore, is full of promise and cannot easily be estimated at its full value. The region is believed to be one of the largest areas of possible oil-bearing country yet unexplored on the face of the Earth, and it is to the exploitation of the oil resources that we look for the greatest development in the basin of Mackenzie River. This must come within comparatively few years; for the oil reserves of the United States are estimated by the United States Geological Survey to be sufficient at the present rate of output for only about thirty years, and there is no large part of the North American continent that gives such promise of new oilfields as the basin of Mackenzie River. Other mineral resources of this part of the unexplored regions are coal, gypsum, salt, and deposits of lead and zinc, the first two of which are known to have a wide distribution.

In the unexplored Cordilleran regions it is not so easy to forecast the possible mineral wealth because the geological disturbances that have taken place in the mountains prevent our making any reasonably accurate guess as to what the geology is, such as can be done in the other parts of the unexplored territory.

Other natural resources which these unexplored regions no doubt contain are furs, game, fish and forests; but as incentives to exploration they all occupy relatively unimportant positions compared to the chance of finding fabulously rich gold or other mineral deposits. It is to the mining industry more than any other that we must look for co-operation and assistance in the exploration of our northern regions.

The purely geographical results to be obtained are to the geographer well worth the time and effort required to obtain them, and the field is still rich in such things. In travelling down the Mackenzie River, for example, on the small Hudson Bay Company's steamer, one passes the mouths of large streams flowing in from the east and west about which absolutely no information can be obtained, and the desire to stop and explore them is very difficult to repress. At the same time one hears from the Indians stories of lakes 60 or 70 miles in length that the white man has never seen; or a glimpse is caught of a distant mountain range whose valleys and summits are virgin territory, and even the Indian cannot satisfy your desire for information regarding it. If there is such a lack of geographical information on the country in the immediate vicinity of the Mackenzie River, a stream which has been constantly used by travellers for over one hundred years, how much greater is our ignorance of the more inaccessible parts of the north country, say in the heart of the Mackenzie Mountains, the Labrador Peninsula, or the Barren Grounds! Certainly

the man who knows most of northern Canada knows also how much exploratory work still remains to be done.

In commenting upon the area of unexplored territory that remains within the borders of the Dominion, Dawson remarked that it might be considered a reproach upon Canadians as indicating a lack of justifiable curiosity on what the country contains. That reproach still remains and will continue so long as such a large proportion of the country remains unexplored. Expeditions into the Arctic are useful in many ways and add much to our knowledge of those little-known regions; but it seems so much more reasonable and even imperative that explorations should be carried out in the more accessible parts of our unexplored territory, not for the geographical results alone, but on the chance of finding something on which to build productive industries and to open fresh outlets for our national energy. For there is nothing, climatic or otherwise, to prevent people from living and working throughout the whole year in any part of the mainland of Canada if there were reasons for doing so, and that without much sacrifice of comfort or convenience.

Except for the isolation and the distance from the centres of population, life for the few white people in those northern regions presents no serious hardships, and indeed in time becomes so attractive that there is no desire for a change to the more settled and civilized regions. For the natives, however, who depend for their food supply almost entirely on fish and game, life is a constant struggle, and the law of the survival of the fittest holds more rigidly in those northern regions than in more temperate climates. It is not only the severity of the climate and the conditions under which they live but the uncertainty of the food supply that are the causes of a high mortality rate. Game is very plentiful in certain parts at certain seasons of the year; but some of the animals, especially the caribou, on which so large a proportion of the natives depend for food, are migratory, and a change in the course of their migration, or the periodical dying out of the rabbits, has always been attended by starvation and hardship, and has in the past been the cause of occasional lapses towards cannibalism. If it were not for the food supply of fish it would be very difficult and almost impossible for the natives to exist at all in parts of northern Canada, and it is fortunate that the lakes and rivers of the whole country are stocked with such a variety and abundance of food fishes. Probably no country in the world is better supplied in this respect.

All northern Canada is well supplied with rivers and, except in the Cordilleran region, lakes also are very numerous. It lends itself therefore very readily to exploration by canoe, which indeed is the only method of travel possible in summer. The Indian summer routes all follow the watercourses. Dogs are used as pack-animals to a limited extent in the mountains in summer, and in winter they are the only means of transport, though good exploratory work cannot be done at that season. The practice of the Geological Survey of Canada in the past has been to send out

small parties in the summer, consisting of an experienced geologist, a topographer, a naturalist, and sufficient canoemen to man two or three canoes. Rapid reconnaissance surveys are made with boat log, Rochon micrometer, telemeter, or plane-table; astronomical observations are made for time, latitude, and compass variation; many photographs are taken, and observations made on geology, mineral deposits, natural history, ethnology, climatology, water power, volumes of streams, and other natural phenomena. Supplies are carried in the canoes to last two, three, or sometimes four months, depending on the extent of country to be covered, and expeditions are made into all parts of the country. Such parties are not expensive, and give the best results for the money expended, though the results depend very largely on the ability and experience of the leader of the expedition. These methods have been very successful in the past and will no doubt be continued in the future; for it is difficult to see how any radical change or improvement can be made in them, having regard to cost and the physical characteristics of the country to be explored.

Progress, however, is slow, and because of the distance to be travelled and the area to be explored it is hardly possible for one of these summer expeditions to spend more than three months in new territory; in the more northern areas, because of climate as well as distance, the limit is two months. Allowing for delays on account of storms and bad weather the average length of new routes surveyed by a single party, now that all the easier water routes have already been traversed, would be about 400 or 500 miles. This amount is bound to decrease as time goes on, and it becomes necessary to follow routes that are more and more difficult. To make up for loss of time exploratory parties will soon be compelled to winter in their fields, but even where this is resorted to it will take many years to cover the ground that remains for the Canadian explorer.

[Note by the Editors: In the paper on the same subject, read before the Ottawa Field-Naturalists' Club, and published with a map in the *Ottawa Naturalist*, May 1890, the late Dr. G. M. Dawson computed the then unexplored area as 954,000 square miles. (See *Proceedings R.G.S.*, New Series, vol. **12**, p. 555.) See also the paper by Professor W. L. Grant, *Geographical Journal*, vol. **38**, p. 362, October 1911.]

ON THE ACCURACY OF BASEVI'S DETERMINATIONS OF THE VALUE OF GRAVITY IN INDIA.

R. D. Oldham, F.R.S.

IN the years 1865–71 a very elaborate series of determinations of the value of gravity at a number of stations in India was carried out by Captain J. P. Basevi, who lost his life when trying to complete the series by observations in the centre of the Himalayan Range, but not before he

had completed a determination at Moré, at a height of 15,427 feet above the level of the sea. These observations were afterwards completed, tabulated, and published ('Account of the Operations of the Great Trigonometrical Survey of India,' vol. 5, 1879). They immediately attracted attention on account of some remarkable peculiarities revealed, and none more than the observation at Moré, which was of an especially remarkable character, and has been discussed from various points of view in connection with speculations on the origin of mountains and of the phenomenon known to geodesists as compensation.

The accuracy of these observations was unquestioned till in 1893–97 fresh observations were made at some of Basevi's stations by the Austrian Navy, which indicated that the earlier results were all in defect by about ·040 dyne. For this and other reasons it was decided to inaugurate a new series of gravity determinations, and the first result of these was to reveal a discrepancy of over ·100 dyne between the value adopted, as the result of prolonged and numerous observations, at Dehra Dun by Basevi and that obtained by Colonel G. P. Lenox Conyngham in 1904. As the new survey proceeded, observations at a half-dozen of Basevi's stations revealed defects of the value of the force of gravity varying from 0·026 to 0·110 dyne, distributed without any apparent reference to locality, and the conclusion appeared inevitable that the whole of the older observations were affected by an irregular source of error, the amount of which could not be estimated with any approach to accuracy in any individual instance. From this conclusion it seemed to result that the whole of Basevi's observations ceased to have any value, and would have to be ignored. A comparison of the old and the new observations has, however, convinced me that this conclusion goes too far, and that Basevi's results, if properly interpreted, have still a real value and importance where they have not been superseded by more modern observations.

In making a determination of the amount of the force of gravity at any place the first step is the measurement, with the utmost accuracy, of the period of a pendulum of known dimensions. To this measurement certain corrections have to be applied for the effect of temperature, of the pressure of the atmosphere, and of the flexure of the stand. The first two of these corrections were known and applied, so far as they had been determined, in Basevi's time; but the necessity of the last had not been recognized, and it was considered sufficient if the stand was sensibly rigid. It has however been found that even the most massive and solidly built masonry will yield more or less to the swing of the pendulum and so affect the period; and a method has been devised by which this effect can be measured and allowed for. Had Captain Basevi followed the usual course of having brick pillars built at each station for the support of his instrument, we should have had to do with a source of error of variable and undeterminable amount; but instead of adopting this procedure he

constructed a strongly braced wooden stand, which was carried from one station to another, and always erected on a platform constructed at ground-level. This procedure and apparatus were used at every station except three; at Mian Mir and Moré a tripod stand of lighter construction was used, and at Dehra Dun the heavier stand was mounted in a specially constructed room, in a manner which seriously modified the results. The observations may therefore be divided into three groups: (1) the standard stations, at which the heavy braced stand was mounted on a platform at ground-level; (2) the stations of Mian Mir and Moré, at which the lighter tripod stand was used; and (3) the station of Dehra Dun. In each of these groups the conditions of observation were so different that no comparison is possible, and each must be dealt with separately.

At six of the standard stations observations have been made in the newer series, and in every instance the older value is in defect, as compared with the newer, by amounts which are shown below:—

Mussooree	... ...	·042 dyne
Nojli ...	... ...	·027 ,,
Kaliana	... ...	·047 ,,
Colaba ...	... ...	·026 ,,
Madras ...	... ...	·042 ,,
Kalianpur	... ...	·052 ,,
	Mean	·039 ,,

This difference may be taken as representing, presumably, the correction for the effect of flexure of the stand, which should have been applied to Basevi's values. It will be seen that this correction varies between the values of $-·026$ and $-·052$, with a mean of $-·039$ dyne, so that, if Basevi's values are expressed in the metric system to the second decimal point and a correction of $-·04$ applied, the result will be correct within ·01 dyne of the true value.

We now come to the stations of the second group, at which the lighter stand was used. This stand was not tried by Basevi at any of his standard stations, and so we have no basis for a direct comparison; but we have Colonel Lenox-Conyngham's observation at one of the stations, Mian Mir, at which it was used. Here the later observation gave a defect of ·109 dyne as compared with the earlier, a defect which may be attributed to the flexure of the stand. From this it seems that the use of the lighter stand introduces a correction of about twice as much as in the case of the heavier, and probably an uncertainty in the same proportion, so that the correction which must be applied to Basevi's determination at Moré will lie within the limits of $-·11 \pm ·02$ dyne.

At Dehra Dun the same stand was used as at the standard stations, but the observations were made in a room specially adapted for the purpose of determining the temperature correction; in this a set of flues

was built and a temporary wooden floor put in, at a level of 5 feet above the original concrete floor of the room, the wooden stand being supported on four brickwork pillars each 5 feet high by 1½ foot square at the base, tapering to only ½ foot square at the top. Seeing that Colonel Lenox-Conyngham, using pillars 1 foot 8 inches high by 2 feet 3 inches square at the bottom and 1 foot 6 inches at the top, and a much lighter apparatus, found it necessary to introduce corrections of from ·015 to ·020, and in one case as much as ·035 dyne, it is easy to understand how the taller and more slender pillars and heavier pendulum used by Captain Basevi might introduce an error, due to flexure of the support, of ·100 dyne. There is independent evidence that this is the correct explanation of the discrepancy in Basevi's preliminary observation at Dehra Dun, which was made in a simpler routine of observation, but agreed with the standard ones in being made with the same stand, supported on a solid platform at ground-level. The value obtained was equivalent to 979·036 dynes ('Account of the Operations,' etc., vol. 5, p. 118), or ·027 dyne less than that adopted by Colonel Lenox-Conyngham as the result of his observations.

CIVILIZATION AND CLIMATE.

Civilization and Climate.— Ellsworth Huntington, Ph.D. Yale University Press. (London: H. Mitford.) 1915. Pp. 333 + xii. *Maps and Diagrams.* 10*s.* 6*d. net.*

PROF. HUNTINGTON has aimed in this work at constructing two maps of the world, the first to show the distribution of civilization and the second to show the distribution of those combined climatic effects which make for efficient human labour both mental and physical. Since civilization is an aspect of human efficiency, and since the two maps agree in their main outlines, it is urged that the climatic factors are partly responsible for the distribution of civilization as it occurs both in the past and in the present.

The measurement of civilization has already been described in these pages (*Geogr. Journ.*, vol. 47, p. 51, January 1916) in our review of a pamphlet which now forms part of the larger book. It will suffice here to recall the fact that the civilization map which Prof. Huntington has made differs little from a map of the world showing the density of population. The complete investigation into civilization was then considered, and the re-examination of that study in relation to the whole book does not lead the writer to change the views previously expressed.

The major portion of the complete work deals with climatic effects and consists of three sections. The first is introductory and discusses previous attempts, such as those of Ratzel, to demonstrate the importance of climate as a factor in the development of civilized life. The method

adopted by these earlier investigators depends upon the examination of typical cases of outstanding value; it is the method of samples; and for that reason there still exists a diversity of opinion regarding climatic influences on man.

In the first part Prof. Huntington calls attention to the fact that racial inheritance forms an important element in determining the degree of civilized life in a community, but he concludes that in an environment which is climatically less stimulating the race deteriorates. This section is based upon qualitative methods; but the second section is essentially quantitative and calls for the detailed discussion which follows later.

The third section is historical and involves the reconstruction of facts regarding, first, civilized man and, secondly, climatic changes during previous centuries. The results upon which the conclusions depend are admittedly somewhat speculative, and Prof. Huntington covers ground which he has already made familiar to the reader of his previous publications. The main hypotheses are the idea of pulsatory changes in climate and the conclusion that the changes consist primarily in a shifting of the belt of storms. It is suggested that the developments of civilized life in Egypt, for example, coincided in point of time with a period of greater frequency of cyclonic storms.

We may now deal with the quantitative methods of the second section, taking them in order of presentation. An investigation of the working powers of 550 people in three New England factories during four years 1910–1913 leads to the conclusion that these workpeople vary in efficiency with the season. Efficiency is low in January; rises gradually to a distinct maximum in June; drops during the summer and rises to a pronounced maximum about November 1, then drops again to the end of the year with a suggestion of a maximum in the middle of December. This variation is markedly climatic. The general trend of events is checked by the consideration of a variety of other examples of seasonal variation in physical ability; these include tubercular patients at Saranac Lake, N.Y., deaths in New York State, school children in Denmark, operatives in cotton factories in South Carolina and Georgia, carpenters in Florida, cigar-makers in Florida, and operatives in a factory at Pittsburgh. The march of the seasons demonstrably affects physical efficiency in the east of the United States. Is mental efficiency similarly disturbed? Prof. Huntington examined the records of the students at West Point and Annapolis, two highly specialized educational institutions, and discovered two points of maximum efficiency, both at a temperature of about 40° Fahr. (*i.e.* the mean temperature out-of-doors, not in the study or the classroom), one in the autumn in November, and the other in the spring in March. From all the collected data it is concluded that the temperature has a marked effect on mental and physical activity. A variety of confirmatory evidence is adduced to show that probably all organisms function best at a definite optimum temperature, and that in the case of the human beings

who have been tested these optima are about 60° Fahr. mean temperature for physical and 40° Fahr. for mental energy.

Daily weather changes are next examined, and it is found that the greatest amount of energy is to be expected in climates where the mean temperature first rises 2° or 3° a day for a few days and then drops 4° to 8° a day. A slight rise is beneficial, but a more pronounced fall is stimulating, provided the people are accustomed to such changes. Neither a hot spell nor a severe cold snap yields such valuable consequences. This conclusion is also based upon experience in the Eastern United States. The next investigation covers the changes during the passage of a cyclonic storm. During an average spell of weather people are least efficient on clear days and most efficient on the second cloudy day at the end of the storm.

Based upon these results consideration is now devoted to "the ideal climate," which should occur where the mean temperature never falls below the mental optimum of 38° Fahr. or rises above the physical optimum of 60° or possibly 65° Fahr. There are four such areas: England, the Pacific coast just north and south of 49° N., New Zealand, and the West Coast of South America near the boundary of Chili. Extremes of humidity are shown to inhibit the effects of temperature, and consequently certain areas such as Ireland are not ideal although they satisfy the conditions of temperature.

Professor Huntington has, therefore, allowed for three climatic factors: first, the mean temperature month by month; secondly, the daily weather changes due to storm frequency; and, thirdly, relative humidity; and has constructed a map of the world showing a distribution of human energy on the basis of climate. This map shows two areas of maximum energy, one in the United States westward from the Maritime Provinces of Canada and the New England States, and the other in Western Europe, including the British Isles, Denmark, France, Germany, parts of Italy, Austria-Hungary, Scandinavia, and Western Russia. These areas shade off gradually to areas of very low energy within the tropics, and rise further south to areas of high energy in Patagonia, Tasmania, and South Island (N.Z.). Japan has high but not maximum energy.

At this point it will be well to summarize the limitations of the data which Professor Huntington has examined. Only a small number of samples have been measured, and this is especially the case in regard to mental energy where the conclusion rests upon an investigation in two notably peculiar institutions. Most educators will agree that in schools there are two maxima of mental energy in a year: one in the spring and the other in the autumn. This is true in England, and the result would be for England an optimum temperature for mental efficiency of about 50° Fahr. But it is somewhat doubtful whether the results are due to temperature, and are not due to the educational system which causes new work to be undertaken in the autumn and examinations to be taken in the

spring or early summer. Under this system the autumn maximum is probably due to interest in the new subject-matter studied, possibly intensified in consequence of a long holiday during the summer, and the spring maximum to a desire to do well in the examination which will determine promotion in school or success in after life.

In the case of physical energy most of the inquiry has been devoted to factory workers. It would be a useful check to inquire into the efficiency of miners, farm labourers, and navvies. Suppose, for example, that the physical efficiency of these manual labourers depended upon different optima, then the areas of maximum human energy on the world map would necessarily be altered. It is also evident that the main results depend upon inquiries concerned with the Eastern United States; does it necessarily follow that a physical optimum of 60° Fahr. which is true for a temperature range from 40° to 60° is equally true where the temperature range is from 15° to 30°? It would appear that Professor Huntington's generalizations with their world-wide sweep are based upon somewhat slight foundations, both as regards the area in which the people work and the types of workers examined.

At this stage the separately conducted inquiry into the distribution of civilization is introduced, and a comparison of the two world maps on which the main thesis depends suggests the following hypothesis, as a possible variant to that adduced by Prof. Huntington. The hypothesis is suggested by the fact that the main features of the civilization map reproduces those contained in a world map showing density of population. The distribution of coal is independent of climatic conditions, yet within the last few decades the distribution has determined the distribution, first, of wealth, and, secondly, of dense populations in North America and Europe. The dense populations of both continents are comparatively wealthy, and hence have developed a standard of life and a capacity for factory labour which are unequalled elsewhere. On inquiry it has been determined that the factory operatives work most efficiently in the Eastern United States under certain definite climatic conditions; it is assumed that similar conditions in Europe tend to equally efficient manual labour. Consequently the two distribution maps are bound to agree as regards these two areas; and their agreement may merely represent the results of the measurement from two separate points of view of the single fact that man tends to adapt himself to his environment. For it should be noted that the optimum temperature for efficiency does not represent the theoretically ideal conditions for human labour, but the measured best for a special area in a limited field of inquiry. Mental efficiency and physical efficiency outside the United States have not been adequately measured. Professor Huntington's methods and results are suggestive, but it may be urged, for example, that similar inquiries should be instituted in London and in Lancashire, and that factory labour in Lancashire, North-East France, and Saxony should be compared. As a test case regarding the validity of the

hypothesis Professor Huntington entered into details regarding the United States, and has made four maps showing the distribution of climatic energy, of mortality, of the education of native white children, and of civilization. These maps, in reality, carry the inquiry no further, for the climate map is a repetition of the results based largely upon factory labour, and the mortality, education, and civilization maps may be assumed to be three functions of the density of population as affected by the opportunity for work and the distribution of wealth. Agreement between the maps is to be expected; disagreement would be surprising.

Although Prof. Huntington has been greatly handicapped by defective data, he has rendered a service in facing the problem of the part played by climate as a factor in geographical environment. It is hoped that his attempt will encourage others to enter the field and investigate the influence on human activities not only of this but of all the other factors of the problem.

B. C. WALLIS.

REVIEWS.

EUROPE.

The Heart of Mendip.— Francis A. Knight. London: J. M. Dent & Sons. 1915. Pp. 547. *Map and Illustrations.*

THIS volume is intended as a continuation of the same author's previous work, 'The Seaboard of Mendip,' published in 1902. It forms a systematic description of ten parishes occupying the western portion of the Mendip hill country, from Loxton on the west to Cheddar on the east—a tract of great interest from many points of view, and one on which the author is exceptionally well qualified to speak from personal experience extending over more than half a century. The district includes in Black Down the highest section of the Mendips, and in the Cheddar gorge a physical feature of unique interest, though otherwise the scenery is marked rather by its quiet charm than by anything exceptionally striking. On the human side its old hill forts and other antiquarian relics, its abandoned mineral workings, its noble churches and survivals of old-fashioned country life, render it well worthy of the attention here given to it. The plan of the book—each parish being systematically described in turn—does not perhaps make so direct an appeal to the general reader as many of the current works of topographical description in which the writer's personal experiences are kept more in the foreground, but for this very reason it is of more permanent value as a record, and may well rank with such standard books of the kind as the late Canon Atkinson's 'Forty Years in a Moorland Parish.'

A Woman in the Balkans.— Mrs. Will Gordon (Winifred Gordon). London: Hutchinson & Co. 1916. *12s. 6d. net.*

Mrs. Gordon and her husband have travelled somewhat extensively in the Balkan Peninsula, the dates of the visits not being given, though some of them apparently took place a good many years ago. Her well-illustrated book is in part devoted to descriptions of these journeys, and in part to summaries of the

history of the different states, and to accounts of their rulers. The journeys were for the most part along the beaten track, and the chief interest of the book lies in its fresh and vivid descriptions of the places and people, and the first-hand accounts of many of the personalities who have figured recently on the Balkan stage. There are numerous photographs, many of them very attractive, and a map, but no index.

Mrs. Gordon entered Rumania from the south, travelling from Sofia to Ruschuk, across the Danube to Giurgevo, and so to Bucharest. She was much struck with the marked contrast in appearance, customs, and modes of life between the Rumanians and the Bulgars and Serbs, and her account of the agrarian problem in Rumania, and of the contrast between the life of luxury led by the great landowners and the poverty of the peasants, is instructive, though perhaps unduly optimistic as regards the effect of recent legislation. But, as already suggested, the chief value of the book lies in its presentation of human life in the peninsula by a sympathetic and interested observer, who had special opportunities in her free access to diplomatic and political circles, and took full advantage of these opportunities.

M. I. N.

ASIA.

From the Persian Gulf to Ararat. An Expedition through Mesopotamia and Kurdistan.— **G. E. Hubbard**, Secretary of Delimitation Commission. Pp. viii. and 273. Edinburgh and London: Blackwood & Sons. 1916. *Illustrations.* 10*s.* 6*d. net.*

This book describes the journey of the Turco–Persian Boundary Commission, which in the spring and summer of 1914 travelled (generally by little-known ways over desert and mountain) from Mohammereh to Azerbaijan. The author, who was Secretary of the British Delegation to the Commission, has not made it his aim to give a close study either of political problems or of geographical and topographical facts. As he says in his preface, "The substance of the book consists of little more than a record of personal experiences and impressions of the tribes and countries through which we passed." Taken as such, the book is good reading. The description of the "Land of Elam" (chaps. iv. and v.) gives an excellent general picture (especially interesting at the moment) of the deserts of Southern Arabistan, of the marshes of the Khor-el-Azem with their reed-enclosed waterways, and of the great empty plains which lie between the Tigris and the Pusht-i-Kuh. After a visit to the pleasant oases of Bedrai and Mendeli, and a glance at Baghdad, the reader is taken through the Turco–Persian borderlands of Kurdistan, where the well-watered valleys with their vines and orchards, walnuts and mulberries, the rugged mountains and execrable "roads," are agreeably sketched. The incidents of the journey are told in an entertaining manner, and meetings with tribesmen, townsmen and vagabonds, sheikhs and aghas, and, last but not least, with the Wali of Pusht-i-kuh himself, provide some amusing and occasionally instructive anecdotes. At the end of August 1914, when the Commission had almost finished its labours, Mr. Hubbard had the misfortune to be wounded—apparently rather seriously—in an attack by Kurds.

Besides what the author describes as the "substance" of the book, a few fragments of history are scattered about it for the benefit of the "general reader." By far the most interesting of these excursions into history is to be found in the first chapter, which gives in outline the story of the Turco–Persian Boundary Question, and the attempts to settle it made by Russia and England

between 1842 and 1913. The behaviour of Turkey and Persia in this matter affords an admirable instance of Oriental diplomacy, and the part played by Russia and England appears to have been on the whole one of the more creditable incidents of Occidental policy in Asia. Enlightening though disheartening is the anecdote of the two sets of maps made respectively by the British and Russian delegations to the first Commission of 1848-1852. When these maps came to be compared in 1865 (the Crimean War being partly responsible for the delay), in eight out of seventeen sheets no less than 4000 discrepancies were discovered. Nevertheless, the surveyors "by some surprising feat of cartography so manipulated the two versions as to produce a single copy, known henceforth by the euphemistic title of the *Carte Identique*." There was naturally much to be done by the surveyors of the last Commission.

This book also contains a chapter in which the now familiar story of British interests in Lower Mesopotamia is told once again, and another on the Kurdish race, which is mainly put together out of Soane, Ross, and Fraser, with a few of the author's experiences thrown in. In the last chapter accounts are quoted of the massacres perpetrated by Turks and Kurds on the Nestorian Christian population of Urmia and the surrounding country in the winter of 1914–15.

There are about sixty photographs in the book, the best being those which illustrate the marches through Kurdistan.

C. G. S.

AFRICA.

The German African Empire.— Albert F. Calvert. London: T. Werner Laurie, Ltd. 1916. Pp. xxix., 335. *Illustrations and Maps.* 6*s. net.*

A general preface is followed by sections on each of Germany's former African colonies. The book is too limited in scope to be a satisfying account of German rule in Africa. It is mainly a record of economic conditions and results. Each section is a useful collection of facts drawn from official and other publications. There are signs among the statistics of careless revision, and there is no index. The numerous illustrations include some coloured plates. The maps are small sketch-maps, showing a good selection of place-names and distinguishing military stations.

AMERICA.

Descripción geográfica de la Real Audiencia de Quito que escribió Don Dionisio de Alsedo y Herrera.— The Hispanic Society of America. Madrid: 1915. Pp. xxxv and 100. *Title, Map, and Index.*

By the courtesy of the Hispanic Society of America a copy of this, its latest publication (of which only 450 copies are printed), has been added to the library. The author's title begins: *Plano geografico y hidrografico del Distrito de la Real Audiencia de Quito . . .*, and comprises more than a hundred words. The work is admirably edited, and besides 110 explanatory notes appended to the text, Don C. A. González Palencia contributes an illuminating Introduction which includes some notice of Alsedo's life and career, as well as many interesting particulars of his writings. These deserve to be better known to English historiographers than heretofore. Only two MSS. of this work are known to exist; both are signed by the author, and dated 1766. They are in the *Biblioteca Nacional* at Madrid. Alsedo, who was born in Madrid in 1690, spent nearly forty years in South America, where he was Governor of the Realm of Quito from 1728 to 1737, and afterwards filled the corresponding office at Panama for six years. Evidently a man of many parts, he seems to

have had a genius for practical political economy. He was much engaged in the repression of contraband trading, and this often brought him to cross-purposes with our merchant adventurers, who in those days were no better than their competitors, and gained Alsedo's cordial distrust.

His description of Quito is tersely written and methodically arranged. His frequent journeyings and official engagements made him personally familiar with the subject of his discourse. His object was to exhibit the physical features, limits, distances, and communications, and the animal, vegetable and industrial products, of each region, as well as the mineral resources which always occupied so large a share of attention in the South American dominions. Here and there, it is true, he breaks off into passing allusions of a historical kind; but these serve to render more sapid a text which, without them, might discover something of the dulness of a gazetteer. This work of Alsedo's was written out of love for his subject; it was no dry official or perfunctory compilation. His style is simple and familiar; and this feature, combined with the novelty of much of his subject-matter, imparts a freshness which constrains the reader who dips into the book, perhaps casually at first, to read on and on. The volume is unquestionably a worthy successor to the *Crónica de la Nueva Espana* issued in 1914 by the Hispanic Society, whose members are doing valuable service in rescuing these priceless records from obscurity and oblivion.

B. G. C.

In the Wake of the War Canoe: A stirring record of forty years' successful labour, peril, and adventure amongst the savage Indian tribes of the Pacific coast, and the piratical head-hunting Haidas of the Queen Charlotte Islands, B.C.— Venerable W. H. Collison. *With 24 Illustrations and a Map.* London: Seeley, Service & Co. 1915. 5*s*.

This is a very readable account of evangelization of certain tribes of the north-west coast of America, and from that point of view would be an excellent Sunday school prize. From our point of view it has value in indicating the social condition of the remarkable people who live in this most favoured country, with its mild climate, wooded hills, and calm drowned valleys. The well-being of the people was largely dependent on the fisheries, and the importance of the olachan or candle fish is clearly brought out. There are various ethnological and anthropogeographical data which have to be sought out from amongst a mass of missionary narrative. Most of the excellent photographs have a distinct ethnological value. The long sub-title sufficiently explains the scope of the book.

A. C. H.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

The Problem of Volcanism.— Joseph P. Iddings, Ph.B., Sc.D. New Haven: Yale University Press. 1914. *Illustrations.* 21*s*. net.

Since the publication of the last edition of Scrope's 'Volcanos,' we have had no text-book of so detailed a nature as Dr. Iddings' 'Problem of Volcanism.' But, while Scrope's work dealt with the subject as a whole, Dr. Iddings' aim is limited to a statement of the main problem of volcanism—the origin and movements of the magma—and to the indication, rather than to the completion, of its solution. A complete theory, as the author remarks, must be the contribution of many workers in different fields. Thus we have no more than a casual mention of the occurrence of earthquakes in connection with volcanic eruptions, there is no reference to the recent work of Omori in Japan, and no discussion

of the relations between the distribution of volcanoes and earthquakes throughout the world.

The eight chapters into which the volume is divided were delivered as a series of Silliman lectures at Yale College, New Haven, in 1914. The first five are of an introductory character, but are too technical, it is to be feared, for the majority of general readers, and yet hardly necessary for students of geology. In particular the discussion of Nebular Hypotheses, in Chapter II., is an unsatisfactory *résumé* of popular expositions of a very controversial subject. The beautiful photographs of nebulæ made with the Crossley Reflector of the Lick Observatory may serve to adorn a book on the subject of Volcanism; but in the present state of our knowledge they do not elucidate it; and their appearance here is not to be commended. The best of the book is the last three chapters, in which the problem is unfolded with undoubted authority and skill.

The volume is well printed: there are few errors of detail (the late Prof. Milne, however, was never knighted, p. 194; and the name of Poincaré is spelled wrong in several places), and the illustrations are admirable.

GENERAL.

The Great Battles of History.— Translated from the French of **Colonel J. Colin** under the supervision of **Spenser Wilkinson.** Pp. 283. 28 *Maps and Plans.* London: Hugh Rees. 1915. *7s. 6d. net.*

The author has selected fifteen of the most famous and best-known battles —in ancient times, Marathon, Arbela, Cannæ and Pharsalia; in the Middle Ages, Rouvines; in modern times, Rocroi, Valny, Jena, Waterloo, and Gravelotte; and in our own days, Mukden and Lule-Burgas.

The authorities which have been consulted are mentioned in the preface. Colonel Colin's masterly analysis of these battles should prove of great value to students of military history. The description of the ground is concise, but sufficiently detailed to explain the conditions in each case.

A quotation from 'Mukden,' pp. 194, 195, illustrates the thoroughness of the author's method:—

"The Mandarin road and the railway from Port Arthur to Harbin skirt the front of the mountains by way of Ta-shih-chiao, Hai-cheng, Liao-yang, Mukden and Tieh-ling, and mark the boundary between plain and mountain belt. East of the line the watercourses come down from the high ground from east to west; west of it they all sweep round southward except the Shih-li Ho, which runs almost straight into the Sha-Ho.

"The plain is quite level and covered with *kaoling*, a kind of millet whose stalks grow to a great height, sometimes as much as 10 feet. In wet weather this plain is impassable; during frost passage across it is in this degree easier that the streams are frozen over, but the cold is terribly severe, and temperatures several degrees below zero (F.) last a long time."

The account of the battle of Gravelotte will prove of particular interest at the present time on account of the details given on the equipment and training of the French and German forces in 1870.

The possibilities of the battle of the future are discussed at the end of the work. It must be remembered that the book was printed before the war began, but not published (in French) till April 1915.

A. W. A.

THE MONTHLY RECORD.

EUROPE.

Evolution of the Surface Features of Fife and Kinross.

IN a paper read by Mr. J. E. W. Rhodes in January last before the Edinburgh Geological Society and since printed in the *Scottish Geographical Magazine* (May 1916) an attempt is made to trace the various steps in the evolution of the present river-system of this part of Scotland and to show how the existing surface features are the result of such evolution, rather than *vice versâ*. He starts from the assumption—borne out by the direction of the deeper valleys and by lines of depression not at present occupied by streams, but still traceable—that the original (consequent) drainage was probably east-south-east, or at right angles to the strike of the older rocks. Subsequent modifications would be determined by the diversity of geological features, of which the most noteworthy are on the one hand the bands of soft Upper Old Red Sandstone occupying respectively the straths of Earn and Allan and the Eden Valley and Plain of Kinross; on the other, the hard igneous rocks of the Lower Old Red Sandstone now forming the Ochils, and those at the base of the Carboniferous, north and south of the coal basin. While the hard rocks have resisted denudation and stand out as hills and ridges, the softer strata have supplied the natural lines along which the subsequent drainage has been developed. The two original streams which ran east-south-east appear to have been thus subjected to a series of captures which diverted their upper and middle courses partly towards the north-east, to the Earn and Eden, and partly to the south-west; the diversion in the latter direction being due to a stream working along the Ochil fault. This beheaded one of the original streams at the Crook of Devon, producing the modern Devon with its upper and lower courses flowing in nearly opposite directions. A later stage was probably brought about by the deposits of the glacial period, which seem to have dammed the Upper Eden at Mawcarse and produced Loch Leven (now 50 feet higher than the Eden only 2½ miles away), which overflowed at the site of Auchmuir bridge and cut a channel through the dolerite, thus once more diverting the upper drainage from the Eden and carrying it into the modern Leven. The paper is illustrated by rough sketch-maps, which are however with difficulty legible and hardly contain all the details necessary for the easy understanding of the author's argument.

River Régime in the French Alps.

The elaborate stream measurements carried out in the French Alps within recent years by the *Service des Grandes Forces Hydrauliques* of the Ministry of Agriculture (cf. *Journal*, vol. 43, p. 186) have for the first time supplied a body of data for a knowledge of the *régime* of the rivers of that region. Advantage has been taken of this by Mlle. A. Main to undertake a study and classification of the streams of the French Alps on the basis of their varying behaviour in respect of high and low stages throughout the year (*Recueil Trav. Inst. Géogr. Alpine, Univ. Grenoble*, tome 3, fasc. 3, 1915). Although they belong as a whole to the Alpine type of river, marked by a strong flood in spring or early summer and a low-water stage in winter, varieties of relief and climate lead to a corresponding variety in the *régime* of the streams, of which the author distinguishes three main types. These are: the high Alpine type, the Mediterranean Mountain type, and the Sub-alpine type, the last intermediate between the other

two and to be regarded as perhaps the most normal. The high alpine type is independent of purely climatic influences, the dominant factor being the supply by snow and glaciers; the Arve at Chamonix is an example. The low stage lasts all the winter with a minimum in February and March, a progressive rise is then maintained until July and August, and a sudden fall takes place in September. In rivers of the second type rainfall is almost the only ruling factor, and such streams reflect almost exactly the variations of rainfall. They show four distinct seasons, with spring and autumn maxima (the latter the most pronounced) separated by two minima, the most strongly marked of which (unlike that of the rainfall) occurs in summer by reason of the strong evaporation and absorption by the ground at that season. The Drôme is an example of a river of this class. Rivers of the intermediate type likewise present two maxima and two minima, but the importance of these is reversed, the spring maximum being the most pronounced and the winter minimum generally more so than the summer one. Here we see an equilibrium between the influence of the snow-melting and that of the rainfall. The author examines the records for the various streams in detail with a view to classing together those of the same type, and seeing how the separate types are combined into complex organisms —*e.g.* the Arve, Isère, and Durance. There is, of course, an indefinite series of gradations by which one type passes into another, and the attempted classification seems bound to be more or less artificial. In fact the general conclusion drawn is that in spite of much variety in detail (resulting from difference of structure, climate, and vegetation in different parts of the area), a general resemblance can be traced in the *régime* of all the rivers, reflecting the unity of the chain of the French Alps and the influence of the winter accumulations of frozen moisture.

AMERICA.

The Control of the Mississippi.

Mr. Wilfrid H. Schoff, whose account of the New York State Barge Canal was referred to in the *Journal* for January 1916 (p. 63), has sent us the reprint of a similar memoir on the Mississippi River Improvement, contributed by him to *Commercial America* (organ of the Philadelphia Commercial Museum, of which he is secretary) for the last three months of 1915. The paper gives a useful *résumé* of the problems to be solved for the improvement and control of the Mississippi and the steps already taken to carry out such improvement, involving, he says, the greatest expense of any undertaking now before the government engineers. The greatest problem, that of controlling the flood waters, owes its difficulty to the fact that the rich soil of the original channel of the river has been fully settled and placed under cultivation, although the secondary channel of modern times is insufficient to carry off the flood waters; and to the lack of any rock foundation for works along the banks. The entrance to the Mississippi from the sea likewise presents a serious problem, and one which has become acute through the increase in the size of modern vessels. The great improvement of the South Pass by Captain Eads in 1875–79, by means of jetties, provided a channel 200 feet wide with central depth of 30 feet, but this was in time found insufficient, and in 1902 it was decided to improve the South-west Pass by supplying a channel 1000 feet wide and 35 feet deep. This was completed in 1908, and an extension of the jetties in 1912, but the use of the newer entrance by ocean vessels has not so far been at the rate anticipated. It is however the best natural outlet, as stated by Eads in 1874, and commerce will no doubt more and more tend towards it in

future. Above the passes the improvement of the river under the auspices of the Mississippi River Commission has involved a vast expenditure of time and money, but the result of study and experiment has been to evolve a system of control by levee and revetment, which has proved the most efficient means of protection to the uncompacted banks. It was thought at one time that the confinement of the river between levees resulted in elevation of the river-bed by silt deposition, but this has not been borne out by observation. The increased height of flood-waves is due to the contraction of the stream, which naturally requires greater height of levee to carry off a given volume. Revetment is especially needed at the bends where the banks are most exposed to the force of the current, and is effected by the construction of great mattresses of woven brush sunk in the mud by a top layer of rubble stone. The necessary work of this kind at all danger points would extend to some 800 miles in all, of which little more than 78 miles is yet in place. Another expedient for the control of the river is the construction of dykes (of timber, brushwood, and rubble) built out into the stream from the banks. In the past great sums have been spent on control works by the States and local interests involved, but it is now felt that though a proportion of the expense should be borne locally the object is a national one, and that the whole work should be in the hands of a central authority.

The Flora of California.

An interesting description of the Californian flora as influenced by climate and topography is given by Prof. D. H. Campbell in the *Scientific Monthly* for March 1916. The flora of the state is extraordinarily varied in accordance with the variety of physical conditions, and at the same time has a very special character owing to its separation from the greater part of the United States by barriers of mountain and desert. In differentiating the various components of the flora temperature and moisture naturally play an important part, and the variations of temperature are due much more to topography than to latitude. The coast region has a remarkably equable climate, and the differences between the means for the hottest and coldest months are only about 10° at San Francisco, whilst a like interval separates the mean annual temperature of the extreme south and north. Going inland, on the contrary, very rapid changes of temperature are experienced. Precipitation, too, is largely controlled by the topography, and there is an extraordinary difference in the rainfall in different parts of the state. Whilst it generally diminishes southward, there may be great differences between stations only a few miles apart. Such differences are plainly reflected in the vegetation, which includes distinct floras differing more widely from each other than any to be found in the Atlantic half of the United States. Extremes are represented by the dense red-wood forests of the cool humid coast region of the north and the excessively xerophytic flora of the Colorado and Mojave deserts in the south. In this direction the plants are largely those of the Mexican region, a characteristic form being the dense "chaparral" scrub, largely evergreen, and very similar to the "Macchie" or "Maquis" of the Mediterranean shores.* A notable element of the Californian flora is one apparently of old world origin, represented by species found also in Kamchatka, or by genera largely developed in tropical and subtropical Asia though not found in Atlantic America. The Californian conifers, as is well known, are remarkable for their size and variety, and reach their greatest development on the west slopes of the middle Californian sierras between 4000

* Well described in Sir A. Quiller-Couch's novel, 'Sir John Constantine.'

and 6000 feet. True Alpine floras are to be found above 9000 feet, though less developed than further north. The isolated position of, and numerous barriers within, the state find expression in the large number of endemic species. Half of the known species of *Lupinus* are found in California, and a large majority of these is peculiar to the state.

AUSTRALASIA AND PACIFIC ISLANDS.

Return of the Easter Island Expedition.

The schooner yacht *Mana* reached England all well on June 24 after three years' absence from this country. The vessel was specially designed and built by Mr. and Mrs. Scoresby Routledge for the purpose of reaching Easter Island, with which there is no regular communication, the object of the expedition being to examine the monolithic remains on the island on behalf of the British Museum. The *Mana* is ninety tons gross, or about the size of the smallest of Drake's squadron on a similar voyage; she has an auxiliary motor engine, and carries a crew of ten all told. The navigating officer for the first part of the voyage was Lieut. R. D. Ritchie, R.N., lent by the Admiralty, and later Mr. H. J. Gillam, the sailing master. The yacht left Southampton on 28 February 1913, and touched at Madeira, Las Palmas, and Cape Verde Islands. She was detained for some weeks at Punta Arenas through trouble with the engine. During her course through the Straits a new waterway was discovered which practically bisects Desolation Island, and an account of which appeared in a former number of this *Journal*. No Indian encampments were found in this district, and general testimony points to the almost complete extirpation of these people by the settlers, owing to their depredations on sheep. This should be realized before all opportunity for scientific investigation of these people has vanished. From Magellan Straits the *Mana* proceeded by the Patagonian Channels. Here on two occasions companies of Indians came out in boats to beg for clothes and other commodities. On reaching Talcahuano, the Chilean naval port, the yacht was refitted by the kind assistance of the authorities, and thence continued her voyage to Juan Fernandez; from that island however she was obliged to retrace her course to Chile and leave there the geologist of the expedition, Mr. F. Lowry Corry, who had unfortunately developed typhoid fever. On his recovery he was compelled to return to England. He joined the army on the outbreak of war, and was killed in action in September 1915. His report on the geology of the Patagonian Channels had been completed.

Easter Island was reached in March 1914, the yacht having been 147 days under way since she left Southampton. The island affords no safe anchorage, and for the sixteen months during which the Expedition was on shore the *Mana* was employed in making trips to the mainland. During these journeys alone she covered 14,000 miles. By these voyages between Talcahuano and Easter Island at different seasons, much information was acquired about a little-frequented part of the Pacific. There is no complete map of Easter Island; but the American chart gives a fairly accurate coast-line, and is more correct than that of our own Admiralty. Detailed surveys of the districts most important from an archæological point of view were made by Lieut. Ritchie, and the exact positions of all the larger mountains were laid down from the ship by Mr. Gillam. The island is volcanic and is roughly triangular in shape. The western angle is formed by an extinct volcano, about 1300 feet in height, with a crater a mile across. This crater is, through coast erosion, only separated from the sea on its outer side by a cliff edge along which it is barely possible to pass. There are no trees on the

island, mainly owing to the fact that it is now used as a sheep and cattle ranch. It has abundant rainfall, but owing to the porous nature of the soil there are no superficial streams, and the water-supply is a somewhat acute difficulty. Subterranean water, however, flows out into the sea in various places below the high-water mark, and the use of this by the natives gave rise to the impression of the early voyagers that they drank salt water. Unfortunately of later years a manager of the ranch thought that the sheep were injuring their health by going down to the sea to drink, and had a wall built round a large part of the coast, carrying it through, and building it of, many of the most interesting remains. The field for research in both archæology and ethnology proved much greater than had been anticipated, and the work was also not destined to proceed without incident. In the first few months there was a native rising which was only terminated by the timely arrival of a Chilian warship, and later the German navy twice disregarded the neutrality of Chile by using the island as a base. On the second occasion the cruiser *Prinz Eitel Friedrich* left on the island the crews of two captured vessels, English and French. The Expedition profited from the services of some of the French sailors, who assisted in excavation at rates of pay refused by the inhabitants. The natives, who are Polynesian in race, are able easily to grow sufficient food to supply their wants, and depend for clothing on the charity of passing ships. They are thus disinclined for all work, and the labour problem is a perpetual anxiety.

The party left in August 1915 and made their way to Tahiti, stopping four days at Pitcairn Island, where a valuable collection of stone implements was secured. The present population consists of those descendants of the mutineers of the *Bounty* who returned to their old home from Norfolk Island. They number 165, and give it as their opinion that the island, which is 5 miles in circumference, would support about 300. Two young men, descendants of the mutineer officer, Midshipman Young, have returned with the *Mana* to England as part of her crew. An effort was made to visit the Island of Rapa, where stone remains are reported; but no chart was on board, the pilot did not come out as the weather was bad, and the attempt had to be abandoned. From Tahiti the route home lay by Honolulu, San Francisco, and tbe Panama Canal. By the courtesy of the American authorities the *Mana* was allowed, as the ship of a scientific expedition, to pass through the canal, although it was closed to shipping. In the Caribbean Sea (Morant Cays) she sighted what at first was supposed to be a ship on fire, and subsequently a naval engagement; it proved to be a submarine volcanic outburst. The bottom was upheaved, and breakers were seen in various directions. As a result the chart will require great alteration.

POLAR REGIONS.

The Shackleton Expedition.

Sir Ernest Shackleton has returned unsuccessful from his attempt to reach Elephant Island in the *Emma* for the relief of his stranded men, and their succour must now depend on the next attempt, to be made in the *Discovery*, which Sir Ernest will join on her arrival in southern waters. He has good hopes that she will be able to penetrate the ice which barred the progress of the *Emma*. Three of the men who accompanied him in his hazardous voyage to South Georgia have now reached this country.

The Lost Russian Arctic Expeditions.

Frequent reference has been made in the *Journal* during the past few years to the two expeditions which left Russia in 1912 for exploration in the Arctic

Seas of the old world, but of which little or nothing has since been heard. With a view to eliciting, if possible, some information as to the fate of the explorers—there can hardly be any hope, now, of their safety—the Archangel Society for the Study of the Russian North has issued an appeal for subscriptions to a fund to be devoted to the furtherance of this object. It is hoped to raise the sum of 25,000 roubles (something over £2500) to be spent in prizes, which will be given during the next three years for information tending to throw light on the fate of the lost parties. Their value will range from 5000 to 500 roubles, according to the value of the information and the difficulties experienced in obtaining it. All whose avocations take them to the Arctic Seas or put them in the way of making inquiries of natives on their coasts are urged to use every effort to bring to light traces of the missing expeditions, and it is asked that any articles or documents substantiating information obtained may be sent to the above-named society. It may be recalled that the expeditions were under the charge, respectively, of Mr. V. A. Rusanoff, geologist, and of Lieut. G. L. Brusiloff, of the Imperial Russian navy. The former sailed in the *Hercules*, and having visited Spitsbergen in the summer of 1912, sent his last message from Matochkin Shar (Novaya Zemlya) announcing his intention of proceeding east through the Kara Sea. Brusiloff, in the *St. Anna*, passed through Yugor Shar on 2 September 1912, with a view to making the North-east Passage. The only information since obtained was given by two members of his party who fell in with Sedoff's expedition near Cape Flora in Franz Josef Land, and reported that the *St. Anna* had been abandoned on 10 April 1914, in 83° N. lat., 63° E. long.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Volcanic Dust-veils and Climatic Variations.—There has been a tendency of late years, encouraged by the results of observations of fluctuations in the intensity of solar radiation, to account for climatic variations of short period, and possibly even those of a secular character, as due to the influence of the dust-veils produced by volcanic activity, which itself seems to be subject to a certain periodicity, and which in past epochs of the Earth's history has no doubt been much more intense than anything known at the present day. The idea is a plausible and tempting one, but that caution is needed against accepting it too hurriedly is shown by H. Arctowski in a paper published last year in the *Annals of the New York Academy of Sciences* (vol. **26**, pp. 149–174). Mr. Arctowski is known as a keen student of climatology, and has paid great attention to the collection of data from all parts of the world. His researches have led him to believe that the periodic fluctuations of temperature which are clearly shown by the crests and depressions of curves of yearly means, especially for tropical stations, are due to some extra-terrestrial factor, presumably to variations of the solar constant. The volcanic-dust theory being in direct opposition to this, Mr. Arctowski in the present paper undertakes a careful analysis of the monthly temperature records for various stations about the periods of unusual volcanic activity such as those of 1883 (Krakatao, etc.), 1902 (La Soufrière, Mont Pelé, etc.), and 1912 (Katmai). In the case of the first period especially he finds that a distinct influence on the temperature curve is traceable, *e.g.* in the records at Pike's Peak, where the crest of the wave marking the temperature "pleion" (which in the regular sequence would have occurred in 1883–84) is entirely suppressed. A decided reduction in the crest is to be observed at many other stations. In the case of the 1902 eruptions no such decided effect is noticeable, the "antipleion" or depression of the

temperature curve next following the eruptions being not fully developed till 1904–5. In 1912, too, the effect of the dust-veil is but slightly appreciable at one or two American stations. On the whole it is impossible to ascribe the normal fluctuations of temperature to any such influence, and Mr. Arctowski still holds that they are the result of changes on the sun's surface or in its atmosphere. The eleven-year sun-spot cycle does not wholly account for the temperature fluctuations, even if it be allowed to show some correspondence with them, the latter exhibiting a double variation within the sun-spot cycle: both seem in fact to be complicated by a variation of shorter periodicity. Mr. Arctowski justly remarks that even were the accordance between volcanic phenomena and temperature fluctuations established, the relation of the two as cause and effect would not follow, as both alike may be due to changes in the solar activity.

GENERAL.

The "Eversley" Engraved Horn.

Among early engraved horns of which specimens are still preserved few surpass in interest that now in possession of Miss Martineau, described and illustrated by Mr. H. Clifford Smith in the volume for 1915 of the *Proceedings of the Society of Antiquaries*. It makes a special appeal from the fact of its having suggested to Charles Kingsley the idea of the "wondrous horns covered with rough etchings of land and sea" which the novelist uses so effectively in 'Westward Ho!' as the means of firing the enthusiasm for adventure of the youthful Amyas Leigh, when shown to him by Salvation Yeo. Kingsley while rector of Eversley was a frequent visitor at Heckfield Place, then the property of Viscount Eversley, where the horn hung in the gun-room and was often handled by Kingsley. Lord Eversley, who as Mr. Charles Shaw-Lefevre had been Speaker of the House of Commons, seems to have inherited the horn from his father, Mr. John Shaw, who in turn probably had it with the Heckfield estate through his marriage with the heiress of John Lefevre. It is an ordinary bullock's horn, 14½ inches in length round the longest curve, and may possibly have been used as a powder-horn. The yellow surface of the widest part is occupied by delicately engraved maps and bird's-eye views of Ports Havana and Matanzas in Cuba, with decorations in the form of full-rigged sailing vessels, human figures, etc. The Royal arms of England are shown as borne by the House of Hanover from 1714 to 1801, but from the character of the mapping the original which served as the copy probably dated from a still earlier period. The horn is no doubt to be associated with some event in the history of Cuba, probably with the second of the two British expeditions against the island carried out within the above-mentioned period (in 1742 and 1762). Of other engraved horns which have been brought to light from time to time most (as was pointed out after Mr. Clifford Smith's paper by Sir Hercules Read) have been concerned with the coasts and islands of America, and were probably carved by sailors. One is figured in Mr. F. W. Lucas's 'Appendiculæ Historicæ: or Shreds of History hung on a Horn,' and represents part of North America now occupied by New York State, including the Hudson and Mohawk rivers and the forts situated upon them.

The Painter's Wife's Island.

This remarkable designation for an island existing only in the fancy of a map-maker is referred to by Swift in a footnote to the 'Tale of a Tub' as offering a parallel to the island of "O Brazile" used by him as the home of an imaginary philosopher. This latter name is of course thoroughly well known

as that of one of the mythical islands (St. Brandan being another) strewn broadcast over the North Atlantic by map-makers of the time just before the discovery of America. But the other name occurs on no map either of that time or of Swift's, and its origin and meaning are a puzzle until the right clue is obtained. As the question has been raised by a correspondent, and some search was necessary in order to find the answer, it may be worth while to explain how the strange expression originated. The Spanish pilot Pedro Sarmiento was taken prisoner by Sir W. Raleigh's ships and brought to England, where he was courteously entertained by Raleigh. The latter having inquired about a supposed island near Magellan Straits, Sarmiento jestingly replied that it was to be called the "Painter's Wife's Island," meaning that it had no existence, but must have been inserted by the map-maker to please his wife with the idea that she possessed an island of her own. The story is told in Raleigh's 'History of the World' (Book II., chap. xxiii., sect. 4), and is quoted by Sir C. Markham in the edition of Sarmiento's voyages brought out by him for the Hakluyt Society (p. 341 *n.*). Peter Heylin in his 'Cosmography' (edit. of 1682) gives an Appendix on the unknown parts of the world, wherein he indulges in a mild pleasantry by including such localities as "Utopia," the "New Atlantis," and even "Fairy-land;" one of the number being this very "Painter's Wife's (spelt "Wives," as also by Raleigh and Swift) Island," the meaning of which he explained, adding, "and I fear the Painter's Wife hath many islands, and some countries too upon the continent in our common maps."

The Anapace Compass.

Colonel W. A. Tilney, whose name is well known in connection with his star-bearing tables and efforts to simplify methods of marching by stars during military operations, has recently brought out what he has called the "Anapace Compass." He claims that by its use it is possible for troops to march at any desired pace on a given bearing by stars at night, or on distant terrestrial objects by day. The instrument consists of a non-magnetic metal disc, somewhat resembling a semicircular protractor, the arc of which is coated with luminous paint to render it visible at night. At the centre of the disc are pivoted three movable arms or pointers, also coated with luminous paint, which can be set to any required bearing on the arc. The middle pointer is longer than the other two, and marked with black bands so that it can be easily distinguished at night. Upon the protractor-like disc is a small luminous compass needle of the ordinary pattern, but with a revolving glass top upon which are two luminous marks, which can be set to the angle of variation so that the bearings shall be true and not magnetic. To facilitate setting the arms to any bearing in the dark, "V"-like notches have been cut round the arc, the larger of which are 10° and the smaller $2\frac{1}{2}$° apart. These "V's" and notches can be counted by touch, so that it is not necessary to see the graduations for setting on the bearings, which is a decided advantage when the light is bad. As the pointers are moved round, a slight click is heard as each notch is passed, and the midway position between two notches can be taken as $1\frac{1}{4}$°, which is about the accuracy to which the instrument can be set. The whole arrangement measures $4\frac{1}{2}$ by $3\frac{1}{2}$ inches, and is fitted with straps for fastening it on to the wrist when in use on the march. To use the Anapace Compass the true bearing on which it is desired to march is first taken from a map, or otherwise obtained, and the longer arm is set to this bearing on the arc. The instrument is then held in a horizontal position and pointed in the direction of the Pole

Star, if this is visible, or some other star of which the bearing at the time is known and previously set on the arc. The movable top of the magnetic compass is then turned so that the marks upon it exactly cover the needle when it is at rest, and the instrument is ready for use. The star pointer, set to the star's bearing, is directed to the star for which it has been set, and the line of march is given by the direction pointer. When any star other than the Pole Star is used due alteration must be made every fifteen minutes or so to allow for its change of bearing. These star bearings can be taken beforehand from Colonel Tilney's star tables, or obtained in other ways, as by means of the Astronomical Compass, and the pointer altered accordingly as time goes on. The object of having the magnetic needle is that it shall still be possible to use the compass when the stars are obscured by clouds. To do this all that is necessary is to hold the compass in a horizontal position and turn it till the needle comes to rest in a line with the luminous marks on the glass, previously set to the variation. Good reports have already been received from those who have used this star compass, and it promises to be of considerable service when stars can be seen during military operations, especially when it can be set by the Pole Star, for which no allowance for change of bearing is necessary. Some better arrangements for sighting would be an improvement, such as luminous marks at the centre where the eye is placed, and at the ends of the pointers; for as it is now it is impossible to sight at all accurately, and quite a large error may be occasioned through this. The compass can be used in the day, either by placing it north and south by the magnetic compass set for the variation as explained, or by bearings of the sun for the times required found beforehand. In the daytime the march should be directed on some distant terrestrial point selected in line of bearing of the route.

E. A. R.

Memorial to the late Prof. Herbertson.

The former students of the School of Geography at Oxford are arranging to erect a memorial to the late Prof. A. J. Herbertson. The desire has been expressed that an opportunity to contribute to the memorial fund should be afforded not only to those friends of the late Professor who may care to do so, but also to that extensive circle of students and teachers of geography who, although not members of the School at Oxford, yet derived so much advantage from Dr. Herbertson's teaching and writings. A committee has been formed to promote the scheme, and contributions to the memorial fund will be acknowledged by the Hon. Secretary to the Committee, Mr. James Cossar, School of Geography, 40, Broad Street, Oxford.

OBITUARY.

Lieut.-Colonel A. St. Hill Gibbons.

A MERITORIOUS African explorer of the close of the pioneer period has fallen a victim to the fighting in France in the person of Lieut.-Colonel Gibbons, who, we regret to record, was killed in action on July 15. For the extent of ground covered by his routes in the "dark" continent Colonel Gibbons fell not far behind some of the greatest of African explorers, and though he entered the field just too late to have the chance of sensational discoveries his work was a serious and acceptable contribution to the more accurate mapping of the African interior. Not content with a mere rapid passage through the region

to be explored, he laid a more solid foundation for his map by covering the ground with a network of routes, each affording a check to the others.

The second son of the late John Gibbons of Mossley Hill, Liverpool, the deceased officer was born in 1859, and after completing his education at Christ's College, Cambridge, obtained a commission in the 3rd East Yorkshire Regiment. A keen sportsman and field-naturalist, he was able in 1895 to gratify his bent in these directions—as well as his desire to explore some of the unknown parts of Africa—by undertaking an expedition to the region of the Upper Zambezi. Large parts of this were still little known away from the valley of the main river, and Captain Gibbons chose as his field of work the tract extending north from the Victoria Falls, between the Upper Zambezi and the Kafukwe. This he traversed in various directions, controlling his route-survey by astronomical latitudes, to the value of which the late Dr. Ravenstein, who worked up his material on his return, bore testimony. Captain Gibbons was one of the first to enter the country of the dreaded Mashikolumwe tribe, the northern part of which he found to be "high, healthy, well watered, and pleasing to the eye." A good deal of interesting information on both country and people was recorded in the book in which Captain Gibbons described this journey, entitled 'Exploration and Hunting in Central Africa, 1895-96.' This came out in 1898, in which year Major Gibbons (as he then was) set out once more for the Zambezi, as leader of a large and well-organized expedition, to complete the exploration both of the course of the main river and of its upper basin in Barotseland and neighbouring countries. The experiment was made of transporting the goods of the expedition by means of aluminium steam launches constructed in sections, and the transport of these through the gorges and rapids of the lower and middle course of the river was a *tour de force* which engrossed all the energies of the party for a considerable time. One of the vessels was taken within a short distance of the Victoria Falls, being the first steamer to navigate this central part of the Zambezi's course. Arrived at Lewanika's capital of Lialui, Gibbons and his coadjutors—Captains Quicke and Stevenson-Hamilton—undertook journeys in various directions through the length and breadth of the Upper Zambezi basin, and added much to our knowledge of the western tributaries as well as of the headwaters of the main river, the most remote source of which was for the first time located. Thence the leader carried his survey eastward along the Congo-Zambezi water-parting, where his work supplemented that of the Belgian explorer Lemaire, whom he overtook during his march eastward. The journey was continued by Lakes Mweru and Tanganyika to the Upper Nile and down that river to Cairo, and Major Gibbons thus added to the credit of his detailed examination of a more or less compact area the distinction of completing one of the longest African transcontinental journeys so far made, the traverse of the continent from south to north having previously been carried out only by Grogan and Sharp. The material brought home was once more worked up by Dr. Ravenstein, and the resulting map of the Upper Zambezi region, published with the paper read by Major Gibbons before the Society in December 1900 (*Journal*, February 1901) was a distinct advance on anything that had previously existed on that region.

Having volunteered for service in South Africa Major Gibbons remained there till the end of the war, and it was only in 1904 that he was able to bring out the full narrative of his second expedition under the title 'Africa from South to North through Marotseland' (2 vols.). He afterwards took up farming in Northern Rhodesia, and made a journey in British East Africa in connection with the Zionist movement with a view to studying the capacities of its high

plateaus from the point of view of agriculture. On his return he read a paper on this subject before the Society (*Journal*, March 1906). Before the present war he had retired from the army, but he came home from Africa to rejoin, and received a commission as major in the 1st Sportsman's Battalion, afterwards taking command of a battalion of the Liverpool Regiment. He leaves a widow and two daughters.

Colonel Gibbons had been a Fellow of the Society since 1894, and in 1906 was awarded the Gill Memorial in recognition of his work in Barotseland.

CORRESPONDENCE.

Wind-blown Deposits in the United States.

THE letter of Dr. Charles Keyes in the May number of the *Journal* has challenged my attention, not because I disagree with his conclusions, but because I am impressed with the under-estimated importance of them. I have travelled around and about for more than twenty years in regions west of the 2000-feet contour; I have likewise studied the effects of aeolian deposits—or, to express myself in English, of flying dust.

In transporting even moderately coarse rock-waste the effects of the wind are almost incredible. Many of the broad valleys between the eastern and the western scarps of the great cordillera are filled with such detritus to a depth of hundreds of feet. "The wind has nothing to do but to blow, and the sand nothing to do but fly," is the way an old prospector put it. In some localities the formation of a dune many acres in extent, several feet high, is a work performed in a period of time that is measured by days rather than by months. In many comparatively small areas blinding dust-storms are in operation not far from half the time. The old southern mail stage-coach line had a station in Arizona where habitation was almost impossible on account of the flying dust. The helpers there rarely remained any great length of time; occasionally the whole gang would leave in a body. More than once a three-day "Santa Ana" in Southern California has buried kitchen gardens almost beyond reclamation. In Northern Mexico flying dust and dust deposits are on even a greater scale, and the boundaries of the belts of depletion and aggradation are less definite than in the arid region of the United States. At times the finer dust is blown across the coast lowland far out into the gulf.

Here and there, where ephemeral streams born of cloud-bursts have notched channels into the deposits, the manner of deposition may be profitably studied. The wind has a wonderful sorting power, and a wind of given velocity will finally separate particles of similar character into uniform sizes. Increase the velocity, and some of the rolling dust becomes flying dust; decrease the velocity, and particles of the required size drop to the ground; double the velocity, and the carrying power of the wind is increased—theoretically, at least—sixty-four fold. In the stream-cut sections one may sometimes find a layer of particles so perfectly sorted that a mechanical device of mathematical precision could not have performed the work more accurately. For the greater part the deposits of the various wind-periods may be plainly distinguished one from another. The gentle wind, the treacherous Washoe "zephyr," and the fierce simoon pile layers one upon another often with sharp lines of demarcation. In occasional instances the layers show very distinct crossbedding. Not infrequently

the character of the material indicates the character of the wind; sometimes it indicates the wind direction also.

As Dr. Keyes has pointed out, the smaller streams of which the Platte is a type are heavily overloaded with sediments which are or have been wind-blown dust. Years ago when Ben Halliday's coaches were the *équipages de luxe* of transcontinental travel, a driver described the Platte thus: "You won't know when you're gettin' 'cross it, son; for it's a mile wide, 'n' an inch deep, 'n' th' bottom's on top." The description could not be better. The larger rivers, such as the Mississippi-Missouri and the Arkansas, are overloaded, but to a less degree. Neither can carry the sediments delivered to it, therefore the streams must drop and flow around them. In past years the lower Mississippi must have flowed in every part of its wide flood-plain, turning Arkansas into Mississippi and Mississippi into Arkansas; building its bed and banks higher than the flood-plain level, and then abandoning them to make a new channel at a lower level. Surely it is aggradation on a magnificent scale.

But the wind-blown dust which the streams endeavour to carry and cannot is an extremely small part of the total which settles upon an area comprising not far from one-fourth that of the United States. That no positive knowledge of the volume of the dust mantle which settles on the Mississippi-Missouri basin exists is greatly to be regretted. On the Atlantic seaboard, where the air is very clear, the daily dust mantle is probably in excess of 1/10,000 of an inch. But inasmuch as my measurements cover a period of only two years—and the area is a very small one—these figures must be taken *cum grano salis*.

Nevertheless, the fact remains that the dust content of the atmosphere settles faster than it is carried off; therefore, east of the region of depletion, aggradation is taking place. Nor is it safe to assume that, because aggradation is taking place, continental lowering is not occurring at the same time. If one reasons from cause to effect, even without the positive evidence of fact, the conclusion that a concurrent lowering is taking place becomes irresistible; for the isostatic balance must be preserved. But, for the sake of argument, admitting that the evidence of lowering cannot be positively established, when we examine the bordering region of depletion the evidence of uplift is beyond doubt. If, now, the Geological Survey and the Weather Bureau will devise a plan for the measurement of dust transportation, we may hope to see some very interesting theories put to the test.

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Mount Vernon, New York.

GEOGRAPHICAL LITERATURE: ADDITIONS TO THE LIBRARY.

Edward Heawood, Librarian, R.G.S.

For list of abbreviations see January number.

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Montenegro und Ober-Albanien als Kriegsschauplatz. Von Kurt Hassert.

Belgium—Luxemburg—Language. **Langhans.**
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Das deutsche Sprachgebiet in der belgischen Provinz Luxemburg, der westlichste Ausläufer des mitteldeutschen Sprachbodens. Von P. Langhans. *Map to follow.*

France—Alps—Hydrography. **Main.**
Recueil Trav. I.G. Alpine (*Grenoble*) 3 (1915) : 243–335.
Le régime des cours d'eau des Alpes françaises. Par A. Main. *Illustrations.*
See note in the Monthly Record, *supra.*

France—Dauphiné. **Blanchard.**
Recueil Trav. I.G. Alpine (*Grenoble*) 3 (1915) : 337–419.
Le Haut Dauphiné à la fin du XVII^e^ siècle. Par Raoul Blanchard.

France—Dauphiné—Historical. **Duhamel.**
La G., B.S.G. Paris 30 (1915) : 437–442.
La première carte du Dauphiné, par Jean de Beins. By H. Duhamel. *Facsimile.*

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Mouvement de la population en Maurienne au XIX^e^ siècle. Par M^me^ Folliasson. *Illustrations.*

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Die Posener Landschaft nach irer Bodenbewachsung, Form und Besiedlung. Von H. Schütze. *Illustrations.*

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Naturwissens. Wochenschrift, N.F. 14 (1915) : 231–235.
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Die Einwirkung der nordischen Vereisung auf die Oberflächenformen der Sudeten. Von Gottfried Hornig. *Illustrations.*

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Vulkanske Udbrud i Vatnajökull paa Island. Af Th. Thoroddsen.

Italy—Aosta—Glaciation. *La G.* (*Novara*) 4 (1916) : 73–85. **Novarese.**
Gli stadi postwürmiani nella Valle d'Aosta. By Vittorio Novarese. *Map.*

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I laghi dell' Appennino Settentrionale e la loro distribuzione. By G. Anfossi. *Sketch-map and Illustration.*
See note in the Monthly Record, May, p. 381.

Italy—Basilicata—Landslip. **Basutti and Simotomai.**
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La frana di Savoia di Lucania. By Renato Biasutti e Hidezò Simotomai. *Maps and Illustrations.*

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La pastorizia nella campagna romana. By Giorgio Pullé.

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Italy—Latium—Historical. **Almagià.**
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La grafia e la pronunzia dei nomi di comune e frazione di comune della provincia di Alessandria. By Giovanni Jachino.

Italy—Sicily—Mount Etna. *B.G.S. Philadelphia* 14 (1916): 37–59. **Hyde.**
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Italy—Stromboli. *Atti R.A. Lincei, Rendiconti* 25 (1916): 316–321. **Platania.**
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Memorial Vol. transcont. excurs. Amer. G.S. (1915) 349–356.
The surface of central Norway. By Werner Werenskiold. *Map and Illustrations.*

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The growth of the port of Archangel.

Russia—Guide. **Heyking.**
A practical guide for Russian Consular officers and all persons having relations with Russia. 2nd edit. Revised and amplified by Baron A. Heyking. London: P. S. King & Son, 1916. Size 10 × 6, pp. xiv. and 446. *Price* 12*s. net. Presented.*
Contains much useful information not easily obtainable elsewhere.

Scandinavia—Phytogeography. **Samuelsson.**
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Sweden—Norrland. **Tamm.**
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United Kingdom—Coal. **Strahan.**
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On a raised beach on the southern coast of Jersey. By Andrew Dunlop. *Illustration.*

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The great snowstorms of 1916. By L. C. W. Bonacina.
Brings together data on the local distribution and intensity of the snowfalls.

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Essai sur les origines du Christianisme au Tonkin et dans les autres pays annamites. Par F. Romanet du Caillaud. Paris, 1915. Size 8 × 5½, pp. xviii., 210. *Price* 2 fr. 75.

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Ann. G. 25 (1916): 1–22.

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Het vulkaneiland Roeang (Sangi-eilanden) na de eruptie van 1914. Door H. A. Brouwer. *Illustration.*

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De onderafdeeling Redjang der residentie Benkoelen. Door J. L. M. Swaab. *Map.*

Persia—Kurdistan. **Iyassa.**

Journey to the North Persian Kurdistan. By A. I. Iyassa. Petrograd, 1915. Size 10 × 6½, pp. 24. *Map and Illustrations.* [In Russian.]

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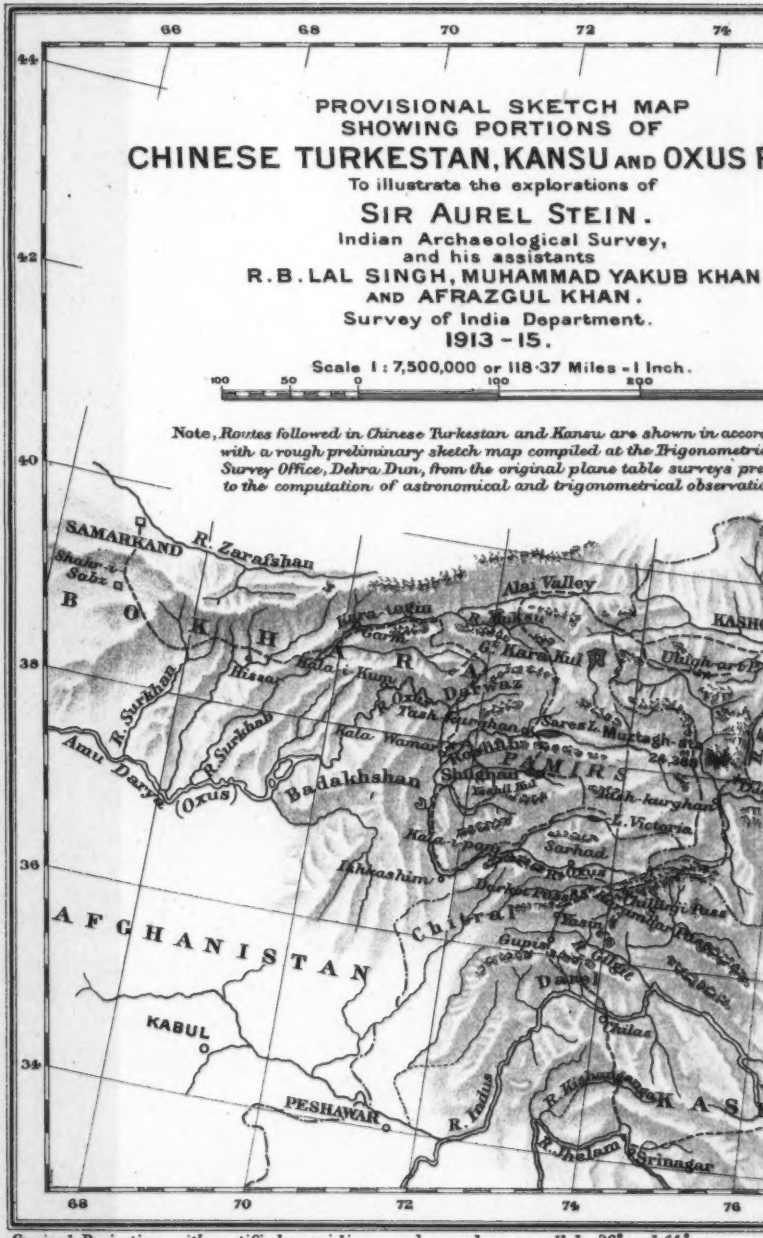

Conical Projection with rectified meridians and errorless parallels 36° and 44°

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Drift sand area
Route traversed
Well or spring
Ancient site
Ancient frontier wall
Ruined watch tower

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CHINESE TURKESTAN, KANSU AND OXUS REGIONS
Stein.